The 'Plane' Truth: A map that identifies infrastructure, resources, assets, and hazards at Dallas Love Field Airport can help Incident Commanders during large-scale emergencies

Lauren A. Johnson

Dallas Fire-Rescue Department, Dallas, Texas

Certification Statement

I hereby certify that this paper constitutes my own product, that where the language of others is set forth quotation marks so indicate, and that appropriate credit is given where I have used the language, ideas, expressions, or writings of another.

Signed: _____

Lauren A. Johnson

Abstract

In every large-scale emergency, Incident Commanders are initially challenged by the lack of a common operating picture and inadequate information and resources to manage the event. This research describes how maps can help Incident Commanders gain situational awareness, develop incident priorities, and make informed decisions throughout a disaster. The problem was that the Dallas Fire-Rescue Department (DFR) did not have a map identifying infrastructure, resources, assets, and hazards that can be used by Incident Commanders. The purpose of this project was to identify and map the critical locations at a site in Dallas that is vital to the well-being of the city: the Dallas Love Field Airport (DAL). Action research was used to answer the questions: (a) What types of locations should be identified and included on a map to help Incident Commanders during large-scale emergencies? (b) What are the advantages of identifying and mapping infrastructure, resources, assets, and hazards? (c) What challenges arise when these critical locations are identified and mapped? (d) What critical locations exist at DAL? (e) How can Incident Commanders use a map identifying critical locations at DAL to formulate incident priorities and make operational decisions? The results contributed to the development of the CRASH (**C**ritical Infrastructure, **R**esources, **A**ssets, and **S**pecial **H**azards) Map of Love Field Airport that can be used by DFR Incident Commanders to manage events that occur in the area. Recommendations included: adopting measures that will increase DFR's understanding of critical infrastructure protection (CIP) programs, identifying and mapping critical locations in order to improve emergency preparedness, and participating in information-sharing networks. Future researchers should: investigate how to develop and maintain a CIP program, identify how other fire departments are integrated into CIP programs, and explore the resources that will be required to respond to an emergency involving the critical locations at DAL.

Table of Contents

List of Appendices

The 'Plane' Truth: A map that identifies infrastructure, resources, assets, and hazards at Dallas Love Field Airport can help Incident Commanders during large-scale emergencies

"Un bon croquis vaut mieux qu'un long discours," is a statement, attributed to Napoleon Bonaparte, which best translates to: "A good sketch is better than a long speech" (Fourcade, 1968, p. 48; Stanek, Friedmannova, Kubicek, & Konecny, 2010, p. 317). As the French emperor aptly noted, visual communication has long been considered an effective means of transmitting information and mapping, specifically, has been a vital tool for military commanders for centuries (Batey, 2012; Phillips, 2011). In fact, mapping and charting are essential not only for military operations; they are fundamental to many municipal functions like emergency response, urban search and rescue, and various civil planning activities (Fox, 2011).

Today, maps are used extensively in the field of emergency management to highlight community vulnerabilities to natural and human-caused disasters, to aid in risk assessment, management and mitigation efforts, and to coordinate response and recovery. Maps provide a visual representation of assets and targets such as population, infrastructure, special hazards, cultural hot spots, and environmental resources (Carpignano, Golia, DiMauro, Bouchon, & Nordvik, 2009). This geographical awareness bolsters the process of informed decision-making by local leaders and supports the prioritization of protection and response efforts related to a disaster or emergency (Stanek et al., 2010).

Fire department Incident Commanders are familiar with the process of prioritizing protection and response efforts; they must make critical decisions at emergencies, often with a limited amount of information, in time-sensitive situations. Frequently, they have maps that they can consult during their decision-making processes. Traditionally, fire department maps have

focused on streets, station locations, and specialized information related to local hazards ("County's Software Exports Maps," 2008; Maxwell, 2006; Schafer, Ganoe, & Carroll, 2007). However, as a result of specific federal guidance and an increased focus on emergency prevention and preparedness, fire departments are being encouraged to identify and map critical infrastructure, key resources, and other elements in their area of responsibility that are vital to the well-being of their communities.

The problem is that the Dallas Fire-Rescue Department does not have a map identifying infrastructure, resources, assets, and hazards that can be used by Incident Commanders during large-scale emergencies. Initially, in every disaster, Incident Commanders are challenged by the lack of a common operating picture and inadequate resources to control the emergency (Chen, Sharman, Rao, & Upadhyaya, 2007; Jiang, Hong, Takayama, & Landay, 2004; Turoff, Chumer, Van de Walle, & Yao, 2004). The research described here indicates that maps can be powerful tools to help Incident Commanders gain situational awareness, formulate incident priorities, and make operational decisions throughout the stages of an emergency or planned event.

The purpose of this research was to address this problem by identifying and mapping infrastructure, resources, assets, and hazard locations in a segment of Dallas that is central to the welfare of the city: the Dallas Love Field Airport. The action research method was used in this applied research project (ARP) to explore the following five questions: (a) What types of locations should be identified as infrastructure, resources, assets, and hazards and included on a map to help Incident Commanders during large-scale emergencies? (b) What are the advantages of identifying and mapping infrastructure, resources, assets, and hazards? (c) What challenges arise when the locations of infrastructure, resources, assets, and hazards are identified and mapped? (d) What infrastructure, resources, assets, and hazards exist at Dallas Love Field

Airport? (e) How can Incident Commanders use a map identifying infrastructure, resources, assets, and hazard locations at Dallas Love Field Airport to formulate incident priorities and make operational decisions? Ultimately, the answers to these questions were used to develop a CRASH (**C**ritical Infrastructure, **R**esources, **A**ssets, and **S**pecial **H**azards) Map of Love Field Airport that can be used by Dallas Fire-Rescue Incident Commanders to manage events that occur in the area.

Background and Significance

This section describes the city of Dallas, the Dallas Love Field Airport, and the Dallas Fire-Rescue Department. Aspects of the city's population, infrastructure, and risk of suffering a disaster, coupled with the airport's central location, promise to challenge fire department Incident Commanders when a large-scale emergency occurs in the area. Next, the federal guidelines and emergency management recommendations that specifically relate to mapping infrastructure and resources are introduced. Finally, an explanation of this project's relationship to the objectives of the Executive Analysis of Fire Service Operations in Emergency Management (EAFSOEM) class, the goals of the Executive Fire Officer Program (EFOP), and the aims of the United States Fire Administration (USFA) is presented.

Transportation infrastructure has been key to Dallas' development since the city's inception. Dallas was established in 1841 on a ford of the Trinity River at the intersection of two Indian trails when founder John Neely Bryan settled in "the only good crossing point for miles" (McElhaney & Hazel, 2013, para. 1). Soon after, two highways designed by the Republic of Texas were completed close by. For the next century, better transportation into and out of the area was central to Dallas's survival and prosperity.

The city began to experience significant population growth during the mid to late 19th century as major railroad companies moved in to connect the South to the East and Dallas became a prominent supply depot for those traveling West ("Dallas," 2002; Johnson, 2013). The turn of the 20th century brought considerable change as well. Following a devastating flood in 1908, Dallas began implementing a newly commissioned city plan that included several viaducts and the consolidation of railroad lines, and the business, industry, and finance markets started to show remarkable progress. Railroads still stretch throughout the city today; Dallas hosts three class I major freight lines, two passenger train lines, and a regional transit rail – all keep commerce and commuters moving on a daily basis. However, visitors and residents alike still characterize the city as car-dependent (WalkScore, n.d.). Dallas is a major interstate hub; it sits at the convergence of four interstate highways and is supported by a well-developed freeway system.

Dallas is now the ninth largest city in the United States with a population of 1.2 million (United States Census Bureau [U.S. Census], 2012). It is the heart of the bustling Dallas-Ft.Worth metropolitan area and is frequently the top-rated leisure and visitor destination in Texas (Dallas Convention and Visitors Bureau website, n.d.). Every year, many visitors arrive at Dallas's Love Field Airport. The FAA identifier for this airport is DAL. DAL is owned and operated by the city of Dallas and is located seven miles northwest of downtown. It provides commercial, corporate, and general aviation services to seven million passengers annually and offers convenient access to the central business district, the market and trade centers, uptown, and the convention center. DAL is home to Southwest Airlines, one of the nine Fortune 500 companies that are Dallas-based (CNN Money, 2012).

In fact, a wide variety of companies call Dallas home. Information and business service providers dominate the local economy, and Dallas has a higher than average concentration of mining, construction, manufacturing, and logistics occupations (Dallas Economic Development website, 2012). The commercial landscape - banking, construction, retail, technology, finance, energy, and healthcare - seems as diverse as the population. The U.S. Census Bureau gives the following estimates about the people in Dallas: the median age is 31.6 years (younger than the national average), 25.4 percent of the population is foreign-born, and the majority of the city's residents are Hispanic (43.9 percent). Non-Hispanic whites account for 28.6 percent of the population, and non-Hispanic blacks represent 23.4 percent (United States Census Bureau [U.S. Census], 2012). Consequently, Dallas is fortunate to have a number of cultural hotspots, as well as fine dining, several professional sports and arts venues, and other entertainment options for residents to experience. "Dallasites" can still enjoy activities along the Trinity River, where the city first began. Actually, there are a number of recreational areas near the banks of Dallas' many local lakes and reservoirs.

The demographics, business and entertainment communities, the airport, and transportation infrastructure in Dallas are relevant to this research because they describe the working environment for DFR. These characteristics are also related to Dallas' vulnerability to certain natural disasters and, in some aspects, they represent targets that are at risk for terrorist attacks. In response to the growing challenges of maintaining a safe and secure metropolitan area, the Dallas Fire-Rescue Department has evolved into an all-hazards emergency response organization. The Department conducts its own training academy, provides fire safety education and inspections, arson and fire cause investigations, explosive ordnance handling and disposal, emergency medical services (EMS), technical rescue, hazardous materials response, aircraft

rescue and firefighting at two airports (Dallas Love Field and Dallas Executive), swift-water and shore-based rescue, and wildland firefighting (Johnson, 2012). Fifty-seven fire stations are staffed by three 24-hour shifts and the stations are grouped into nine battalions; a battalion chief supervises each battalion. The city is further divided into two, roughly northern and southern halves, which are overseen by deputy chief officers. DFR responds to about 220,000 incidents each year. For all incidents, DFR utilizes the Incident Command System (ICS) and, per departmental policy, battalion chiefs become the Incident Commander once they arrive on scene, and they remain "In Command" until a higher-ranking officer, usually a deputy chief, relieves them.

Like many metropolitan departments, the majority of DFR's incidents require EMS assistance and the smaller minority consists mostly of fires, hazardous materials releases, and specialized rescue calls. Multiple-alarm fires are not uncommon, but other large-scale emergencies such as multi-casualty incidents (MCIs) or specialized rescue responses caused by floods, tornadoes, explosions, plane crashes, chemical and industrial accidents, and intentional acts of terrorism are unusual. For Incident Commanders, success at managing events of this type greatly depends on the availability, distribution, and effective use of information (Dimova, 2010; Van de Walle & Turoff, 2008). DFR Incident Commanders have a variety of information resources available for consultation during large-scale emergencies, but they do not have a map that highlights infrastructure, resources, assets, and hazards. Maps that are specifically designed to aid emergency response can provide an "intuitive medium for communication" and they establish a common operating picture for Incident Commanders working on scene (Bianchetti et al., 2012, p. 350).

The chances that DFR will respond to a large-scale emergency scene are becoming more and more likely. The city of Dallas has master emergency operations plans for disaster responses caused by extreme weather, aircraft accidents, and terrorism. Fire department Incident Commanders have clearly defined roles in each of these plans. The following section describes the factors that impact the city's risk for suffering a large-scale emergency that are specifically related to these types of disasters and gives special attention to the elevated risk of disaster at or near the area of the Love Field Airport.

The common saying: "If you don't like the weather in (pick your city or state), just wait a minute," certainly applies to Dallas. The climate is humid, with mostly mild winters, but locals and visitors endure months of extreme summer temperatures. Occasionally, ice storms cause widespread, prolonged power outages and traffic disruption during the winter months. Historically, tornadoes and strong storms have posed the largest natural threats to the area.

Strong storms lead to hail and troublesome flooding annually for certain parts of Dallas. Flooding as been associated with disasters in North Texas since the early 1800's and the Love Field Airport has sustained damage because of tornadoes, hail storms, and flooding over the years (Furlong, Ajemian, & McPherson, 2003; Hively, 2011; Mahaney, 1997). The airport, like all other areas in Dallas, is vulnerable to a variety of weather-related emergencies. However, these types of emergencies can present a different set of challenges for fire department Incident Commanders when they occur at DAL.

The rain, wind, and reduced visibility conditions that accompany severe storms have resulted in aircraft crashes, caused delays in the identification of the aircraft type and accident sites, and have slowed the arrival of Aircraft Rescue Fire Fighting (ARFF) resources (Veillette, 2010). Severe weather impacts not only the initial response but the recovery and rehabilitation

phases of emergencies as well. For example, researchers documenting the US Air Flight 1016 crash near the Charlotte/Douglas International Airport in North Carolina noted the sweltering heat that exhausted the recovery workers and investigators who were operating at the accident site (Barry, 1994). Additionally, weather can influence environmental safety in the case of a plane crash because it affects jet fuel, firefighting foam, and biohazard fluid "run-off" and evaporation.

Severe weather conditions are not the only hazards that may impact the Love Field Airport area. The airport is situated in a highly congested part of Dallas. It is bordered by a lake and mixed-use developments: homes, apartment buildings, schools, churches, restaurants, retail and industry, as well as critical infrastructure locations that include a hazardous materials freight rail line, a public rapid transit rail line, a water treatment facility, several fuel farms, a power plant, and a city bus yard. Traffic accidents are very common on the public roads adjacent to the airport, and hazardous materials incidents (at fixed facilities and in transport) also occur frequently as there are manufacturing plants and warehouses close by.

Certainly, there is nothing inherent about an airport that causes an increased risk for suffering a weather, traffic, or hazardous materials-related disaster, but the areas closest to the airport and the airfield itself are at an increased risk of an aircraft accident. The Dallas Emergency Operations Plan recognizes that there is an ever-present possibility of catastrophe caused by fallen aircraft throughout the city ("Fallen Aircraft Plan," 2003). However, extensive research indicates that the vast majority, between 70 and 80 percent, of aircraft accidents occur at or near airports, during the take-off and landing phases of flight (*Aircraft Rescue and Fire Fighting*, 2008; Boeing Commercial Airplanes, 2006; National Fire Protection Association [NFPA], 2013; Netjasov & Janic, 2008; Sheikhpour, Shirazian, & Safa, 2012).

An aircraft crash near DAL will most likely cause fatalities and injuries to passengers and area inhabitants ("Fallen Aircraft Plan," 2003). The term “groundling” is used to describe a person on the ground that may be injured or killed by an unintentional airplane crash. Research indicates that groundling fatality risks are concentrated near airports; risks are significantly higher within the first two miles around an airport and the risks associated with busier airports are higher than those related to less busy airports (Boeing Commercial Airplanes, 2006; Netjasov & Janic, 2008; Thompson et al., 2001). DAL is a medium hub airport[1] and ranks 45th in the number of passenger enplanements among all U.S. airports (Federal Aviation Administration [FAA], 2013).

Air travel is one of the fastest growing means of transport, and air traffic is predicted to increase over the next two decades (Federal Aviation Administration [FAA], 2012; Netjasov & Janic, 2008). As air traffic increases, there is a reduction in separation between aircraft (in time and space) and there are concerns that this may lead to an increase in the number of aircraft accidents (Boeing Commercial Airplanes, 2006). However, this risk may be mitigated by the advancements in aircraft technology and passenger safety (NFPA, 2013).

Dallas Love Field is preparing for the full repeal of legislation (the Wright Amendment) later this year that will release restrictions that limit the number of gates and the types of interstate flights that air carriers can operate from DAL. This is expected to dramatically increase the number of gates, flights, and passengers at the airport. Additionally, these changes will strengthen the economic impact of DAL by an estimated one billion dollars (*Airport Impact Analysis*, n.d.). Currently, Love Field contributes about $3.5 billion to the local economy; it generates funds that support Dallas’ tax base, the airport and its tenants employ thousands of area

[1] Airports enplaning .25 to .99 percent of total enplanements (Federal Aviation Administration [FAA], 2012)

workers, and it provides a comprehensive set of aviation services to the businesses and residents of Dallas (ibid.).

DAL is a valuable resource to the community and DFR plays a vital role in supporting passenger safety and maintaining the continuity of operations at the airport. A National Transportation Safety Board (NTSB) study found that the survival rate for passengers on an aircraft that crashed on or near an airport equipped with ARFF services was greater than 16 survivors for every person killed (National Transportation Safety Board [NTSB], 2000). This study notes that a critical factor necessary for successful rescue is the speed at which qualified personnel are dispatched and begin to work (Veillette, 2010). DFR provides the ARFF services for DAL. Fire Station #21 is dedicated to the full-time protection of the DAL airfield with a staff of seven (a captain, a lieutenant, three drivers, and two fire/rescue officers) and three ARFF apparatus and Fire Station #42 provides supplemental ARFF protection to DAL in addition to all other emergency response duties. These ARFF stations are notified of aircraft emergencies instantly over their stations' dispatch speakers; when the Air Traffic Controller reports the emergency to Dallas' 911-call-center, the conversation is simultaneously broadcast to the stations. To be effective, upon notification, rescuers must immediately determine the location of the downed aircraft and identify the fastest route possible to the scene (*Aircraft Rescue and Fire Fighting*, 2008; Veillette, 2010).

Unfortunately, weather and aircraft accidents are not the only likely causes of a large-scale emergency at DAL. The city of Dallas consistently ranks highly on lists of terrorist targets because of its population, soft targets like an ex-president's home, sports venues, and major events (the NBA All-Star Game, the NCAA Final Four, and the Super Bowl), and its economic position in the national marketplace. In 2009, the Department of Homeland Security (DHS)

upgraded Dallas-Ft.Worth to the Tier 1 / high-threat urban area list, and although DHS does not use the Tier 1 and Tier 2 classifications any longer, the Metroplex remains one of the 31 Urban Area Security Initiatives (UASI) eligible urban areas (Gillman, 2009; Wright, 2014).

History has shown that transportation systems are common targets for terrorists (Greenberg, Lowrie, Mayer, & Altiok, 2011). And, securing airports against terrorist attacks has been a high priority of governments worldwide, especially since September 11, 2001. Primarily, the existing threats involve a terrorist that is determined to destroy an aircraft in flight, or one that intends to use a weapon or aircraft to attack buildings, key resources, and infrastructure on the ground (Stewart, Netherton, Shi, Grant, & Mueller, 2012). The amount of critical infrastructure and key resources located near Dallas Love Field is remarkable; Southwest Airlines' headquarters is on the airport campus, and DAL is within miles of the American Airlines Center, the Federal Reserve Bank, the Dallas Convention Center, and the George W. Bush Presidential Library. Air Force One lands and departs from DAL when the President visits the Dallas/Ft. Worth Metroplex. Additionally, the Bachman Water Treatment Plant, the Dallas Area Rapid Transit (DART) Blue and Yellow Lines, and a class 1 freight railroad all sit adjacent to the perimeter of DAL. Note that, in the U.S., terrorism risk is positively correlated with both population density and infrastructure concentration (Chatterjee & Abkowitz, 2011; Simonoff, Restrepo, Zimmerman, Naphtali, & Willis, 2011). And, as mentioned above, DAL is located in a popular urban area; about 33,000 people live in the two zip codes that are closest to the airport (U.S. Census, 2012).

Thus far, this section has described the many reasons to make Dallas Love Field Airport and the area immediately surrounding the airfield a priority when it comes to disaster planning and emergency response. DAL represents a financial interest in the city, it is co-located with

infrastructure and within a densely populated area, it is a terrorist target because it is the base for a large transportation system, and it is vulnerable to weather and aircraft emergencies. Certain federal guidelines and emergency management researchers and practitioners recommend that local jurisdictions concentrate on locations like DAL, identify critical infrastructure and key resources that are at risk, and use maps to support their planning for and responses to disasters.

In fact, a number of countries and international organizations, the United Nations for example, recognizes the necessity of safeguarding critical infrastructure (Njotini, 2013; Quigley, 2013). Since the September 11, 2001 terrorist attacks, a fervent national focus has highlighted the importance of identifying and protecting critical infrastructure and key resources at the local level in the U.S. And, in the years following, several natural disasters have reinforced the necessity of these efforts and taught emergency managers the value of planning for the unexpected (DerHohannesian & Kreckle, 2011). Recently, DHS released a revised version of the *National Infrastructure Protection Plan* (*NIPP*). This plan presents a set of broad goals and priorities aimed at ensuring public and private sector critical infrastructure security and resilience (*NIPP*, 2013). It is one of several federal documents designed to guide risk management activities so that the services, structures, and systems that are vital to national security and economic well-being, and to the public's health and safety, are robust and can withstand attacks from both natural and man-made disasters. Another federal directive, *Presidential Policy Directive 21*, requires that, in order to protect critical infrastructure security, appropriate departments and agencies "map geospatially, image, analyze, and sort critical infrastructure" (The White House Office of the Press Secretary, 2013, para. 23). Finally, the DHS's *Comprehensive Preparedness Guide 201: Threat and Hazard Identification and Risk Assessment* details how communities should identify, manage, and plan for local-level risks as well as

ascertain the abilities and resources that will be required to address the risks (*CPG 201: THIRA*, 2013). The content of these documents provided the foundation for this ARP because they describe the importance of identifying and mapping local infrastructure, resources, assets, and hazards.

Relatedly, emergency management researchers and practitioners insist that identifying and mapping infrastructure is critical to planning and preparing for a disaster. Within emergency management, there is a considerable amount of communication that is related to spatial information and geography (Greenberg et al., 2011; Stanek et al., 2010; Zupan, Sruk, & Franges, 2012). And, emergency managers recommend that planning should take place first in the areas that are densely populated and contain critical infrastructure (Simonoff et al., 2011). Researchers believe that mapping disaster vulnerability and resources in advance can help predict the extent of impact, save lives, and identify local needs before, during, and after a large-scale emergency (Dimova, 2010; Mishra, Fuloria, & Singh Bisht, 2012; Morrow, 1999).

Emergency responders rely on maps during the preparation, response, and recovery phases of disasters. Maps that have been customized to certain agencies or task groups, like emergency response or the gas, water, and electric utilities, can be designed to include only the amount of detail necessary to make a decision and this increases the speed of decision-making (Schafer et al., 2007; Stanek et al., 2010; Wood, 2011). Recognizing this, fire departments have started arming their firefighters with aerial photography and detailed imagery of response locations so that they can begin to plan their actions while still en route (Harrington, 2007). However, Dallas Fire-Rescue is not currently equipped with these technologies and first responders use a map on their mobile data computers (MDCs) that shows streets, bodies of water and green-spaces, and fire hydrants only. Indeed, a more-detailed map that is tailored to DFR

emergency response can help Incident Commanders make operational decisions and allocate resources more effectively.

This ARP was designed to create a specialized map of the Dallas Love Field Airport that identifies and charts infrastructure, resources, assets, and hazards for DFR Incident Commanders. Throughout the research process, this researcher considered the challenges of commanding the emergency response to an all-hazard, large-scale incident at the airport, and this type of critical thinking supports the objectives of the Executive Analysis of Fire Service Operations in Emergency Management course (*Executive Analysis of Fire Service Operations*, 2012, p. SM 5-1). This project is also aligned with two strategic goals of the United States Fire Administration: "Goal #2 – Improve local planning and preparedness," and "Goal #3 – Improve the fire and emergency services' capability for response to and recovery from all hazards" (United States Fire Administration [USFA], n.d., p. 15). Lastly, this research conforms to an overall goal of the Executive Fire Officer Program, which is to solve adaptive challenges in the fire service. Certainly, a map can be considered a technical fix for the problem presented here. But, readers will find that this research invites an overall change in the way DFR Incident Commanders prioritize areas and structures during large-scale emergencies when they are operating with insufficient resources. This type of triage, completed during or after life safety concerns are addressed, and according to the structure or system's usefulness or service to the city, is an improvement in fire service operations and an advancement in critical infrastructure protection.

Literature Review

A literature review was performed to examine the existing research related to the identification and mapping of infrastructure, resources, assets and hazards. The review revealed

the benefits and challenges of identifying and mapping these types of locations and it provided a foundation for the research questions in this ARP. Overall, the importance of identifying and mapping critical locations during the planning and preparedness phases of emergency management is well established and supported in the literature.

Yet, it should be noted that literature specifically related to how fire department Incident Commanders can identify and use this information to make operational decisions was a priority for this review. However, only a very small number of peer-reviewed research articles related to this particular subject were found. This may be due to the fact that many state-level operations are still in their infancy and fully integrating local emergency responders is still a few years to come. Another complicating factor may be the annual decline in state and local budgets, because this may make the development and maintenance of a critical infrastructure program impractical (H. Perriott, personal communication, February 10, 2014; February 26, 2014). Therefore, this researcher aimed to address this gap in the existing literature by focusing on how the fire service can begin to design and use maps of critical locations in order to speed decision-making, improve communication, and support operational decisions during large-scale emergencies.

What types of locations should be identified as infrastructure, resources, assets, and hazards?

The answer to this question was used to focus the data collection segment of this research. This phase often demands the most time, so it was critical to identify what information was necessary before beginning the process (Tran, Shaw, Chantry, & Norton, 2009). Likewise, researchers note that information overloading is a common problem in cartographic communication and that data collection should focus on only the necessary amount of data required to make a decision (Stanek et al., 2010). Considering this, the following section

describes the types of locations that should be identified and mapped by emergency response organizations.

DHS recognizes that different approaches for data collection are necessary depending on how the information will be used. Specifically, sectors and agencies, like fire departments, that are responsible for protecting fixed assets and physical facilities can benefit from a ground-up, asset-by-asset approach to critical infrastructure identification (Department of Homeland Security [DHS], n.d.). Researchers consider this approach to be "based on context" because maps are designed according to particular tasks or functions, like emergency response (Stanek et al., 2010, p. 319).

The federal government has provided direction on how risk managers should identify infrastructure and prioritize the data collection process. Critical infrastructure is defined as those:

> Systems and assets, whether physical or virtual, so vital to the United States that the incapacity or destruction of such systems and assets would have a debilitating impact on security, national economic security, public health or safety, or any combination of those matters. (*NIPP*, 2013, p. 29)

Federal plans indicate that the systems and locations that have the highest risk and the potential for the most disastrous consequences should be pinpointed first. Risk measurements for physical assets or locations, like the targets of this project, are an expression of the likelihood that a hazard will occur and affect the site, the extent that the site is vulnerable to hazards, and the level of impact, or consequence, that can be expected if a hazard occurs (*NIPP*, 2013). Furthermore, it is recognized that although the national plans prioritize systems and locations according to their significance at the federal level, other agencies and subdivisions of government can view

“criticality” differently when it comes to identifying locations (DHS, n.d., p. 4). Emergency response organizations should use an all-hazards approach to evaluate the infrastructure and determine protection priorities in their communities because every disaster is initially a local event; communities must identify the possible threats to their area and assess their resources and ability to respond ("Fact Sheet," n.d.; Lindell & Perry, 2007; Schafer et al., 2007).

Infrastructure locations that have been impacted by past events should be identified and mapped; for instance, locations that have proven vulnerable to floods are likely to be affected by floods again unless efforts are made to mitigate their effects (Greenberg et al., 2011; Santella, Steinberg, & Parks, 2009). In cases like these, using historical records and staff experiences to identify susceptibility is recommended. Yet, risk managers must also plan for the unexpected because it is possible that an event can occur that is outside the historical record and/or is the result of a deliberate, intentional act (Greenberg et al., 2011).

In addition to identifying infrastructure locations that are vulnerable to natural and human-caused disasters, it is especially important for emergency response organizations to identify areas that present life-safety concerns or can be used as a resource during a large-scale event. It is beneficial to have advance knowledge of how many children are located in specific neighborhoods; this will facilitate planning for rescue as well as for appropriate sheltering accommodations (Morrow, 1999). Extreme age, either very young or very old, influences vulnerability to disaster, as do disabilities and self-care limitations (Carpignano et al., 2009; Morrow, 1999). Additionally, Morrow (1999) suggests that tourists can be highly vulnerable during a disaster because they do not have a local support network to help with recovery. Therefore, group homes, nursing homes, schools, and hotels should be identified and mapped as special hazards because they are locations that house vulnerable populations. However, some of

these locations can also be considered resources because they can be used as shelters in the event of an emergency.

Similarly, the National Fire Protection Association's (NFPA) *Guide for Airport/Community Emergency Planning* recommends identifying areas that can be used as gathering and sheltering locations for disaster victims that are not transported to hospitals (National Fire Protection Association [NFPA], 2013). These locations can be community centers, parks, and other places that have electric power, heating and air conditioning, as well as shower and toilet facilities. Many times, these resources can also be identified as staging areas and supply drops for teams and equipment that are involved in the disaster response. Researchers have noted, when describing the lessons learned from hurricane Katrina, that one major failure was that no medical supplies or food were staged at the Superdome, which had been designated in advance as a place of refuge (Chua, Kaynak, & Foo, 2007).

The NFPA also advocates identifying alternate sites that can be used as support centers for disaster response and recovery (National Fire Protection Association [NFPA], 2014; NFPA, 2013). Structures suitable for use as a temporary mortuary, command post, and emergency operations center should be named and mapped during the planning phases of disaster management. Areas that can be used as triage and decontamination sites, and medevac zones should be considered resources as well (NFPA, 2013; Maxwell, 2006).

Finally, some locations with unique characteristics can impact emergency response operations at an airport and the areas adjacent to an airfield. Some of these sites, like fuel farms, hazardous materials warehouses, aircraft maintenance facilities, and assembly occupancies, may have already been pre-planned by fire departments as special hazards because they require technical skill or alternative tactics to mitigate the emergencies that may occur (National Fire

Protection Association [NFPA], 2010). Other sites may impact emergency response not because of their contents, but because of the landscape or terrain (*Aircraft Rescue and Fire Fighting*, 2008). Bodies of water should be identified and if there are runways within 800 meters, ARFF commanders should develop a water rescue plan (NFPA, 2013). Topography influences fire spread and also determines how emergency vehicles can gain access to the scene of the emergency (Veillette, 2010). Thus, emergency responders should identify the areas, roads, bridges, and entry points that are suitable for use by fire apparatus and other heavy equipment. Along those same lines, fire departments should locate assets that are critical to firefighting and rescue efforts. Fire hydrants and draft sites, for example, should be identified (*Aircraft Rescue and Fire Fighting*, 2008; National Fire Protection Association [NFPA], 2014; Maxwell, 2006).

This section described the types of locations that researchers and practitioners focus on during the planning and preparedness phases of emergency management. The research presented here helped define the categories of locations – critical infrastructure, resources, assets, and special hazards - that are used in this ARP and identified on the CRASH Map. Emergency response guidelines recommend that these locations be plotted on a grid map (*Aircraft Rescue and Fire Fighting*, 2008; *Executive Analysis of Fire Service Operations*, 2012; NFPA, 2013; Maxwell, 2006). For this project, critical infrastructure is specifically the systems and structures that are necessary to maintain the well-being of the city of Dallas and the Love Field Airport. This aligns with the federal guidelines cited here that recognize that public, private, and governmental sectors may have different concepts regarding what is critical to their jurisdiction or industry (DHS, n.d.). In the context of this research, resources are sites that can support emergency response and recovery needs, like the shelter, command post, and mortuary alternatives described in the literature. Similarly, assets are items that are specifically related to

fire and rescue responses like access gates, emergency roads, fire hydrants, and draft sites. And finally, special hazards are locations that require technical expertise or specialized equipment to mitigate an on-site emergency.

What are the advantages of identifying and mapping infrastructure, resources, assets, and hazards?

Existing literature documents the many advantages of using maps to support emergency management efforts. The answers to this research question were used to validate the purpose of this ARP and to justify the data collection process of this project. For example, there are locations at Dallas Love Field Airport that are covertly secured and protected because of their contents or tenants/owners. The documentation of these sites was balanced against the gains that can be made in terms of life safety and property conservation when DFR Incident Commanders are able to use the CRASH Map to make better-informed decisions at large-scale emergencies. This section describes the benefits noted by researchers regarding the identification and charting of infrastructure, resources, assets, and hazards as part of the emergency management process.

In general, maps are visual communication tools that show spatial relationships and patterns, and give an overview and details of a geographic space (Schafer et al., 2007; Stanek et al., 2010). Maps can give a visual depiction of structural and system interdependencies and they can expose the potential for cascading events in an area (Carpignano et al., 2009; Santella et al., 2009). This type of information is especially useful for disaster planning and response.

Maps are considered essential tools by disaster preparedness agencies and they are used to support several activities that are part of the planning phase of risk management. Maps allow for the visualization of risk characteristics across an area. Researchers note that geographic

comparisons are an integral part of the risk assessment and prioritization process. They can encourage mitigation efforts and cooperation among organizations and they can spark dialogue regarding taking protective measures to secure the most vulnerable locations (Carpignano et al., 2009; Greenberg et al., 2011; McConnell & Drennan, 2006; Simonoff et al., 2011; Tran et al., 2009). Shafer, Ganoe, and Carroll (2007) provide a real-world example; they have introduced the process of "geocollaboration," where a group of people works together to solve a geospatial problem, and they note that geocollaboration occurs frequently during the planning and preparing phases of disaster management.

Researchers have found that, in many areas of the world, knowledge about disaster proneness and vulnerability is often passed on only through oral tradition in communities; residents know which locations are safe from flooding, for example (Tran et al., 2009). This is true in the case of emergency response organizations as well. Responders become familiar with the intricacies of their territory, for example, and this knowledge is traditionally shared within their work group but is not written down or shared with outlying companies (Turoff et al., 2004). Mapping can make this local knowledge visible for all users. Importantly, maps can be used to facilitate communication between experts and decision-makers, and between decision-makers and the public at-large (Carpignano et al., 2009; Chen, Rao, Sharman, Upadhyaya, & Kim, 2010; Chen et al., 2007).

During the response phase of a disaster, maps support informed decision-making processes and they increase situational awareness for Incident Commanders and emergency responders (Chen et al., 2007; Corbane, Carrion, & Broglia, 2011). Within the ICS structure, the Planning function is in charge of collecting, evaluating, and providing maps related to the incident (Jiang et al., 2004). And, if the Planning function is not assigned, the Incident

Commander assumes these duties. Maps are essentially information management tools, and success at managing disasters depends on the readiness, supply, and effective use of information during the emergency (Chua et al., 2007; Dimova, 2010).

There is evidence that some difficulties that arise during the response phase of a disaster stem from the "lack of a general geographic information depository and the lack of a common operating picture" (Bianchetti et al., 2012, p. 359). Ineffective decision-making, poor coordination, and wasted time can result from differing perspectives amongst responding agencies (Turoff et al., 2004). Frequently, individual relief workers and federal, state, and local response teams arrive from outside a disaster area and each group brings their own practices, information systems, values, and goals to the site (Bianchetti et al., 2012; Chen et al., 2007; Oliver, 2008). Teams usually rotate in and out, operating for a set amount of time, before another team replaces them (Van de Walle & Turoff, 2008). This can hinder communication, information sharing, and operational performance (Chen et al., 2007). To further complicate the matter, disasters are inherently characterized by uncertainty and unexpected threats (Chen et al., 2010; McConnell & Drennan, 2006; Van de Walle & Turoff, 2008). A crisis typically interrupts normal communication between organizations and limits capabilities for sharing new information (Bianchetti et al., 2012). Maps are commonly used to reduce the possibility of miscommunication and to provide a clear picture of the area and tasks at hand. In fact, research shows that maps decrease the need for communication between emergency group leaders during an incident (Johansson, Trnka, Granlund, & Gotmar, 2010).

Today, Geographic Information System (GIS) technology is commonly providing first responders with maps containing relevant information that they need to make efficient, well-informed decisions en route and once they arrive on scene at an emergency (Harrington, 2007;

Oliver, 2008; Schafer et al., 2007). However, this has not always been the case; following hurricane Floyd, response workers concluded that detailed maps could have provided a much greater benefit if they had been deployed prior to the event and used as part of the planning phase. In the years since, GIS has become fully integrated with emergency management organizations and is used during disaster operations to provide details about the area, the available resources, and to improve data exchange between commanders (Johansson, Trnka, Granlund, & Gotmar, 2010).

As noted here, there are many advantages to using maps in the planning and response phases of emergency management. Maps provide a visual representation of the area, as well as the interdependencies and risks associated with a specific location. They are used to document local knowledge and facilitate communication between locals, officials, experts, and decision-makers. Finally, maps support informed decision-making by increasing situational awareness and they improve coordination by ensuring a common operating picture for all responding agency workers.

What challenges arise when the locations of infrastructure, resources, assets, and hazards are identified and mapped?

This research question was designed to highlight the challenges related to identifying and mapping critical infrastructure, resources, assets, and hazards for an emergency response plan. The answers to this question were used primarily to prepare for the data collection process. However, they also provided the foundation for the interview questions in this project and influenced the content and symbols used on the CRASH Map.

Collecting and organizing information during the emergency planning process is challenging (Budic, 1994; Turoff et al., 2004). Researchers stress that gathering information and storing it in a systematic and easily accessible way is important (Carpignano et al., 2009). Relatedly, identifying ways to validate information and keep it current has become a popular concern in the field of geospatial information for emergency response (Corbane et al., 2011; Maxwell, 2006; Santella et al., 2009; Schafer et al., 2007; Tran et al., 2009). Corbane et al. (2011) found that the main concern is that incorrect information may lead to unsound decision-making that can adversely impact local residents and assets during an emergency event (p. 9).

Research indicates that it is challenging for risk managers to decide what assets should be included on a risk map (Carpignano et al., 2009). Eighty-five percent of the critical infrastructure in the United States is privately owned (Auerswald, Branscomb, LaPorte, & Michel-Kerjan, 2005). So, in some cases, critical infrastructure and interdependent systems can be hard to identify and information-sharing processes are poor or inaccessible (Chatterjee & Abkowitz, 2011; H. Perriott, personal communication, February 10, 2014). Often, private sector owners and operators do not want to disclose information about their operations because it may "be considered proprietary or of competitive value" (Santella et al., 2009, p. 414). Similarly, some sites are not easily identifiable because the federal government or other agencies are actively protecting them as security interests. In other instances, when prioritizing locations for inclusion, practitioners experience difficulty deciding on the worth of "soft" sites that are culturally, environmentally, and/or politically valuable to an area. Researchers point out that there are ethical considerations as well (Carpignano et al., 2009). Finally, distinguishing what information is relevant for the map user is a challenge; this decision is crucial because the

process becomes counterproductive if the user needs to consult various maps in order to make an informed decision (Stanek et al., 2010; Turoff et al., 2004).

Existing literature suggests that there are ways to moderate the challenges of deciding on the map content. Successful mapping programs often rely on a process of two-way communication between map designers and the first-line users (Maxwell, 2006). Likewise, those who develop decision-support tools like maps should involve those who will be performing the command and control functions, as well as the individuals who will be executing the orders on-site (Van de Walle & Turoff, 2008).

Another challenge to the design of a map is developing standardized symbols. It is imperative that a common language must be used, and different organizations and technical groups often have specialized vocabulary and symbols for their trade (Bianchetti et al., 2012; Chen et al., 2007; Johansson et al., 2010; Oliver, 2008). Zupan, Sruk, and Franges (2012) emphasize that "the symbols on custom emergency maps have precise meanings and being identifiable is of particular importance" (p. 918). Symbol shapes, colors, and size also impact a map's usefulness and must be clear for communication to be effective (Stanek et al., 2010).

The subject of developing a map that identifies critical infrastructure, resources, assets, and hazards merits a discussion about how to maintain the security of the information that is represented on the map. Consider that the state of California partnered with DHS to label vulnerable critical infrastructure sites, but chose to list only the address, rather than the specific type of each facility (Simonoff et al., 2011). In general, information security is becoming more and more challenging (H. Perriott, personal communication, February 10, 2014; Njotini, 2013). Businesses and governments are increasingly dependent on computer-based systems and

networks and, as a result, the security of information systems is becoming more susceptible to failure (Choobineh, Dhillon, Grimaila, & Rees, 2007).

This researcher was unable to identify any peer-reviewed research articles related specifically to how fire departments can protect critical infrastructure information. However, there is literature describing how the federal government can guard and share the information that is voluntarily submitted to DHS as part of the Critical Infrastructure Information Act of 2002. The Protected Critical Infrastructure Information (PCII) Program was developed at the federal level as an information protection program that legally shields information from disclosure when requested through the Freedom of Information Act or a similar disclosure law (Office of the Secretary, Department of Homeland Security [DHS], 2006). Researchers seem to agree that the PCII and other programs like it satisfy one important part of the security issue. The *NIPP* acknowledges the challenge of protecting and distributing information so that the appropriate entities can use it for risk management (*NIPP*, 2013). Organizations should clearly identify who will have access to the information and maintain confidentiality based on a "need to know" basis (Auerswald, Branscomb, LaPorte, & Michel-Kerjan, 2005; Quigley, 2013; United States Government Accountability Office [GAO], 2006). The second part of the security issue is how to protect the database, network, and/or documents where the information is stored, and concerns about cybersecurity are understandably extreme, given the constant changes in the virtual environment (Njotini, 2013; Quigley, 2013).

The security concerns and the other challenges associated with identifying and mapping infrastructure, resources, assets, and hazards have contributed to the slow growth of some critical infrastructure protection programs (H. Perriott, personal communication, February 10, 2014). In general, data issues dominate the relevant literature: how should organizations gather, store,

update, and validate critical information? What information should be included and how can it be accessed and protected? Yet, technical challenges to designing a map exist as well; mapmakers should use a common vocabulary and standardized symbols to ensure understanding.

How can Incident Commanders use a map identifying infrastructure, resources, assets, and hazard locations to formulate incident priorities and make operational decisions?

This question was designed to gather information regarding the specific ways that fire department Incident Commanders can use a CRASH Map to make decisions during large-scale emergencies. The Incident Commander position demands timely incident information in order to effectively manage the overall strategy, responders, and resources at an emergency (Jiang et al., 2004). So, what makes a map that identifies critical infrastructure, resources, assets, and hazard locations more useful than the maps that DFR uses today for its everyday response needs? The answers to this question were used to support the purpose of this ARP and to provide a foundation for future recommendations on how to incorporate the use of a CRASH Map into the DFR emergency response procedures for the Dallas Love Field Airport.

In the preceding sections, this review described how researchers and emergency planners use maps of critical infrastructure to identify local vulnerabilities and predict cascading events. Incident Commanders can utilize this information to pre-plan areas and identify response and resource needs in advance of a disaster. They can use the detailed maps to advocate for and obtain needed resources and response plans before an emergency occurs (McConnell & Drennan, 2006).

Once a disaster does occur, research indicates that fire Incident Commanders and responders use these types of maps upon arrival (Stanek et al., 2010). However, one of the

problems that plagues emergency response units is that tools that are not used regularly during normal operations are typically not used correctly, if at all, during a true emergency (Turoff et al., 2004; Van de Walle & Turoff, 2008, p. 297). Workers and managers alike rely on familiar processes and practices during a crisis, so it is important for decision-support tools, like maps, to be incorporated into everyday use (Greenberg et al., 2011).

Incident Commanders can use maps that identify critical infrastructure, resources, assets, and hazards to visualize the extent of the damage and predict the consequences of an emergency. GIS technology, in particular, can speed the damage assessment process (Dimova, 2010). Incident Commanders can evaluate the potential for cascading events, identify vulnerable areas, and develop incident priorities based on protection needs. Detailed maps are used to mark incident boundaries, staging locations, triage areas, and to identify safe routes and traffic patterns for emergency and non-emergency vehicles (Schafer et al., 2007). US Air Flight 1016 broke into three sections and came to rest in a way so that the emergency scene was divided into two sections, in two different jurisdictions (Barry, 1994). In this case, two separate patient triage areas were established, as were two separate perimeters to keep bystanders and media out of the danger zone. The after-action report for this aircraft disaster reiterated the importance of identifying safe zones and redirecting traffic away from the incident. Relatedly, the City of Dallas Emergency Operations Plan tasks the fire department Incident Commander with establishing the hot, warm, and cold zones, in addition to the triage and staging areas.

Some map features help users pinpoint vulnerable areas and measure distances. Topographical maps are used to evaluate the potential for run-off and environmental contamination (fuels, biohazards, firefighting foam). Grids are marked on a map for reference points; this helps responders relay the location of important sites to others and grids also help

estimate distances (*Aircraft Rescue and Fire Fighting*, 2008). In the case of a military crash in Dallas, city policy requires that injured crewmembers and first responders maintain a safe position 2000 feet away from any aircraft carrying ammunition, explosives, or nuclear weapons ("Fallen Aircraft Plan," 2003).

Most importantly, perhaps, maps are used to communicate information to others. Information sharing enables consistency and comprehension among all levels of responders (Chen et al., 2007). For instance, McEntire (2002) attributes the successful rescue operation during the 2000 Fort Worth, Texas tornado to the efficient way that decision-makers and field personnel collected and distributed knowledge between work groups. In Dallas, several other response agencies are expected to coordinate with the fire department Incident Commander to achieve perimeter and entry control (Streets with barricades and Dallas Police with patrol personnel), to secure any damage to the water distribution or wastewater system (Water Utilities), and to ensure the treatment and transport of victims (Parkland Hospital Triage Team) ("Fallen Aircraft Plan," 2003).

Incident Commanders can use a map that identifies critical infrastructure, resources, assets, and hazards to support resource allocation decisions (DHS, n.d.; Tran et al., 2009). Resource allocation is a continuous process and there is no way to predict exactly who and what will be needed during an emergency (Turoff et al., 2004). Yet, resource deployment at emergency incidents and from static locations, like fire stations, has been the topic of study for decades in emergency management, as evidenced by the RAND Corporation/Fire Department of New York partnership, 1968-1975 (Green & Kolesar, 2004).

Chen et al. (2007) observed: “emergency response is typically constrained by the limited resources and its deployment requires the accurate assessment of the incident needs” (p. 208).

Ineffective resource allocation decisions have severely impacted some disasters like hurricanes Katrina and Rita. And, researchers note that strategic, well-informed decision-making regarding the distribution of emergency resources may be more vital to the outcome of the incident than the number or availability of the resources (Chen et al., 2010).

The literature reviewed to answer this research question provided many examples of how Incident Commanders can use a CRASH Map to make operational decisions before and during a large-scale emergency. A map that identifies infrastructure, resources, assets, and hazards can be used to pre-plan areas and organize resources before a disaster occurs. It is important that use of this type of map is incorporated into daily use by Incident Commanders so that the process will be familiar and routine, even when operating in extreme conditions. Once on scene, Incident Commanders can visualize a number of details related to the incident: the boundaries of the damage, the potential impact of cascading events, and the resources that will be required to bring about a safe resolution. Importantly, a CRASH Map can be used to communicate these details to others.

Finally, a portion of this literature review included published works related to the methods used for this research. Literature that focused on the action research methodology was used as a guide for the organization of this ARP (Badham & Sense, 2006; Dickens & Watkins, 1999; Leedy & Ormrod, 2013; Riel, 2010). Examples of action research plans were identified and served as models for the one presented in the next section. Also, semi-structured interviewing techniques were reviewed, as were the advantages and disadvantages of being an insider researcher (Doody & Noonan, 2013; Hart, 2005; Lisheron, 2013; Sproull, 1985).

In summary, the research examined for this ARP related to the process of identifying critical infrastructure and discussed how mapping can be used to improve the planning and

response phases of emergency management. As mentioned, peer-reviewed research articles that specifically describe how fire departments can identify and map critical infrastructure in order to support Incident Commanders during large-scale emergencies are largely absent from the literature. However, the available research does emphasize that mapping critical locations is vital to the decision-making process and this information was used to give direction for this project, with the goal of creating a map that can be used in this way.

Procedures

The purpose of this section is to describe the methods used so that others may reproduce this research. This ARP began with the selection of a research problem that focused on emergency preparedness in the city of Dallas: the Dallas Fire-Rescue Department does not have a map identifying infrastructure, resources, assets, and hazards that can be used by Incident Commanders during large-scale emergencies. Next, the research purpose was developed to address a portion of this problem and the research questions were designed to provide a framework for this study. Interviews, a literature review, and a data collection process produced the answers to the research questions. Electronic mail (e-mail) and telephone calls were used on several occasions to establish rapport, schedule meetings, identify facts, and conduct interviews. The final product of this action research is the CRASH Map that DFR Incident Commanders can use to support operational decisions and resource allocation during disasters and planned events at DAL.

At the beginning, an action research plan was developed in order to document the phases of this ARP, the required activities, the people involved, the time frame and schedule, as well as the resources needed to complete this project. The plan also included an evaluation section so that the researcher could gauge progress and record feedback. Each step in the action plan was

designed to provide answers to the five questions that supported this research. The action research plan can be found in Appendix A.

Throughout the course of this research process, subject matter experts were contacted in order to provide information related to this project. On February 20, 2014, Mark Berry, Section Chief, DFR Communications Bureau, was asked via e-mail to confirm the total number of incidents that DFR responded to during the 2012-2013 Fiscal Year. The purpose of this inquiry was to ensure that the correct number of emergency responses was presented in this report. A copy of Chief Berry's response can be found in Appendix B.

Beginning November 1, 2013, a series of e-mails was exchanged between the researcher, the City of Dallas Emergency Management Coordinator for Aviation, Lanita Magee, and Harvey Perriott, a Protective Security Advisor for the North Texas District of the Department of Homeland Security. Mr. Perriott is a critical infrastructure protection and vulnerability mitigation subject matter expert for DHS. His area of responsibility includes DAL. Ms. Magee is responsible for coordinating all aspects of emergency management at Dallas' two airports, Love Field and Executive. The purpose of the e-mails was to describe this research project and to ask for a meeting to discuss critical infrastructure protection in general, as well as critical infrastructure and key resource mapping at DAL.

On February 10, 2014, this researcher met with Mr. Perriott and Ms. Magee. This meeting provided background information related to Mr. Perriott's role as a Protective Security Advisor. He identified the department that is responsible for infrastructure protection in the state of Texas and described the future plans for information sharing between the DHS and state and local agencies. This meeting lasted for one and one half hours, the researcher made written notes after the meeting, and general statements from Mr. Perriott are cited in this research. Prior to the

final draft of this paper, statements attributed to Mr. Perriott were sent to him for approval to ensure correctness (see Appendix C).

On February 22, 2014, Ms. Magee was contacted via telephone and e-mail to follow-up after the February 10, 2014 meeting. The phone call served to remind her of the project goals and the e-mail was used to ask three interview questions. The purpose of the interview questions was to evaluate specific challenges to emergency planning at an airport, to identify DFR's role in planning for critical infrastructure protection at DAL, and to describe how decision-making and response may be improved with a map that identifies critical locations at the airport. A copy of this e-mail and her responses can be found in Appendix D and E, respectively. Ms. Magee's responses provided background information for this project as well as answers to the research questions listed below.

What types of locations should be identified as infrastructure, resources, assets, and hazards and included on a map to help Incident Commanders during large-scale emergencies?

A literature review of research relating to disaster planning and preparedness, emergency management, critical infrastructure protection, cartography, and fire department and military map use was used to answer this research question. One purpose of this review was to learn from existing research that explained the types of locations that should be mapped by fire departments in order to increase emergency preparedness at the local level, yet the majority of the literature that focuses on fire departments and mapping describes how mapping can be used only for wildland and structural pre-fire planning. Because of this limitation, the researcher relied heavily on literature from the more general field of emergency management. Thus, the goal of this review was modified; the researcher sought to address this research question by

identifying the types of locations that the federal government, researchers, and practitioners focus on during the planning phases of emergency management.

Additionally, interview questions were designed to solicit answers to this research question and to provide details that apply directly to DFR and DAL. On February 5, 2014, the researcher contacted Sergeant Michael Beattie, Dallas Police Department, Love Field Squadron. Sergeant Beattie is an experienced police officer; he has worked at the airport for several years and has also served as a GIS Specialist. The goal of this interview was to capitalize on his unique position as a security officer with a GIS background. Sergeant Beattie was provided details about the purpose of this research and then was asked to describe locations at DAL that represent a sensitive or security interest for the airport. The researcher made written notes during the call and the conversation was brief and informal; a transcript of the written notes can be found in Appendix F. Sergeant Beattie's comments are referenced in the Results section of this paper.

On February 21, 2014, two telephone calls were made to schedule interviews with DFR Battalion Chief Cameron Creager and DFR Battalion Chief Michael Meador. Chief Creager and Chief Meador serve in the two battalions that are "first-due" to emergency incidents at the Dallas Love Field Airport. Both chiefs hold Aircraft Rescue Fire Fighter and Incident Safety Officer certifications from the Texas Commission on Fire Protection. And, each is likely, because of his field assignment, to be the initial Incident Commander at any emergency that occurs at the airport. The purpose of the phone calls was to provide background information related to this ARP and to ask for their participation in an interview. On that same day, e-mails were sent with three interview questions. The initial e-mails and the responses from Chief Creager and Chief Meador can be found in Appendices I - L, respectively. The purpose of the e-mails was to

provide the interview questions, as well as allow the respondents time to gather information and formulate their responses. Both chiefs were asked the question: “As an Incident Commander, what types of information would you like to see on a map of Dallas Love Field Airport?” Their answers contributed directly to the findings for the first research question regarding the types of locations that should be identified and mapped to assist Incident Commanders during large-scale emergencies.

The results of this portion of the literature review, as well as the responses from both battalion chiefs, were used to further divide the types of locations from four into five categories. The locations were separated into five categories: critical infrastructure, key resources, assets, special hazards, and general use. This type of categorization is intended to facilitate quick comprehension by Incident Commanders and responders.

What advantages and challenges accompany the process of identifying and mapping infrastructure, resources, assets, and hazards?

A literature review and interviews contributed to the findings regarding the advantages and challenges associated with identifying and mapping infrastructure, resources, assets, and hazards. The advantages were used to support the purpose of this project, and the challenges that accompany it influenced the research plan and the goals of this ARP. Primarily, the challenges noted impacted the researcher’s decisions regarding how to label certain locations on the CRASH Map. Specifically, because certain tenants, owners, and building contents represent a security concern for DAL, only the building’s intended use and addresses are labeled.

Ms. Magee answered an interview question concerning the specific challenges of emergency planning at an airport, and a portion of her response was used to answer the research

questions listed here. As mentioned above, the written summary of her responses can be found in Appendix E. Similarly, Mr. Perriott spoke in detail about the security challenges that DHS is facing while trying to design an information-sharing network that federal, state, and local agencies can use. His contributions to the findings presented here are cited in both the Literature Review and Results sections of this paper.

What infrastructure, resources, assets, and hazards exist at Dallas Love Field Airport?

This research question was designed to elicit the data necessary for building the CRASH Map of the Dallas Love Field Airport. This map is the final product of this research and can be found in Appendix G. Several sources were used to identify the addresses and types of structures that are located on the airport's campus. The details of the personal communication, maps, blueprints, and fire survey and inspection databases that were used to answer this research question are described below.

On January 19, 2014 e-mail and telephone correspondence was initiated with DFR GIS Specialist Laura Spray. She provided an aerial photo map of DAL with addresses that became the foundation map for this project. On February 12, 2014, the researcher used the addresses from the map to perform a search of DFR's Tactical Information System (TIS) and DFR's fire inspection records. TIS books are three-ring binders containing printouts of information and diagrams that DFR uses to pre-plan tactically significant buildings. They are carried on every battalion and deputy chief car in the city. DFR's fire and life safety inspection records are maintained on the Internal Document System (IDS) network in a program called Firebase. The researcher matched the addresses from the DAL map to those in the TIS books and the Firebase system in order to identify any locations that had been labeled as tactically significant or had

been granted a work permit for flammable and combustible liquids, hazardous materials, high pile storage, welding, cutting, hotworks, and/or spray painting and dipping. These locations were then labeled as special hazards for inclusion on the CRASH Map.

On February 14, 2014, Victoria Tortolero, Airside Operations Manager, at DAL was contacted via e-mail by the researcher in order to provide background information on this project and to request a meeting to discuss critical locations at the airport. On February 19, 2014, the researcher met with Ms. Tortolero and Jennifer Gammill, DAL Operations Training Coordinator. Ms. Tortolero and Ms. Gammill both serve in positions that demand knowledge of the airport's layout, the content of leased spaces, and the location of people, resources, and systems that support the day-to-day functioning of DAL. The purpose of this meeting was to classify the addresses that remained unidentified after the TIS and Firebase searches and to discuss any areas of concern that DAL Operations officers have regarding protecting critical infrastructure. Ms. Tortolero provided blueprints of the gas, water, sewer, fuel, and electric systems, as well as a map showing all buildings and roadways at DAL. The meeting lasted for one hour. The utilities identified on the blueprints and the newly identified locations were added to the CRASH Map during the meeting described below with the GIS Specialist.

On February 18, 2014, the researcher met with the GIS Specialist to start the first draft of the CRASH Map. A Critical Infrastructure/Key Resources (CIKR) Map from the EAFSOEM class was used as an example to give the Specialist an understanding of the end goal of this project. At this meeting, layers of data were added to the foundation map. Some layers (fire stations, fire hydrants, access gates, and streets) already existed in the GIS program because they have been used to build maps for other departments and occasions. The GIS software used to build the CRASH Map was ESRI ArcView, Version 10.1. The researcher used a Microsoft

Excel spreadsheet to document all addresses from the foundation map. Each address was assigned a number and given a category label based on its contents or intended use. As mentioned above, the categories were critical infrastructure (yellow), resources (blue), fire department assets (green), special hazards (red), and general use (white); combinations of categories were designated in certain cases. Next, the numbers and colors were added to the structures and other types of locations on the CRASH Map. Table 1 lists the items that were identified and plotted from the blueprints and general map of DAL onto the CRASH Map.

Table 1: Types of locations that were identified and plotted on the CRASH Map, by category

Critical Infrastructure	Resources	Assets	Special Hazards	General Use
ATC Tower	Parking lots	Patrol road	Fuel farms and cabinets	Office buildings
Bachman Water Treatment Plant	Parking garages	Access gates	Bachman Lake	Rental car businesses
DART Rail	Police locations	Fire hydrants	Fuel lines	Industry/Warehouse
Railroad	City offices	Fire stations	Biohazard disposal	
Passenger terminals	Flight Museum		Maintenance facilities	
SWA headquarters			Electric vault	
			Manhole access	
			Gas lines	
			Fixed-base operators	
			Hangars	
			Ammunition and explosive storage	

On February 24, 2014, the researcher met again with the GIS Specialist to complete the final draft of the CRASH Map. The purpose of this meeting was to ensure that all critical locations had been correctly identified, categorized, and mapped. When the final draft of the CRASH Map had been completed, a Map Key was created that shows the number, category, and address of each critical location at DAL. The Map Key information is sorted by emergency grid number. These efforts contributed to the final product of this action research and provided the

answers to this research question. The CRASH Map and Map Key can be found in Appendix G and H, respectively.

How can Incident Commanders use a map identifying critical locations at Dallas Love Field Airport to formulate incident priorities and make operational decisions?

Interview questions and a portion of the literature review were designed to address this research question. This part of the literature review was motivated by the need to understand how a map that identifies critical locations can be used to improve decision-making and resource allocation at large-scale emergencies. The review also highlighted how these types of maps can be used for pre-planning strategies as well as obtaining and staging resources in advance of a disaster, and these examples are noted in the findings.

Specific interview questions were used to give insight about how DFR Incident Commanders anticipate using a map like this during a large-scale emergency at DAL. DFR Battalion Chiefs Creager and Meador were asked, “As the first-due Battalion Chief and the initial Incident Commander at DAL, can you describe how this type of information could support your decision-making regarding incident priorities and resource allocation?” Their responses to this question are cited in the findings of this paper. In an effort to provide some background information and to give contrast, another question was used to pinpoint the current resources that DFR Battalion Chiefs use to find information related to critical locations at DAL. General statements from both battalion chiefs regarding this question are also cited in this project.

Additionally, Ms. Magee was asked to describe how DFR’s decision-making and response might be improved with a map that identifies critical locations at the airport. Recently, as the Emergency Management Coordinator for Dallas’ Aviation Department, she has had the

opportunity to observe DFR's responses to simulated emergency incidents at DAL. She was asked to draw on these experiences for her answer and documentation related to this question can be found in Appendix E.

Limitations

There were some limitations associated with this project. This section is designed to describe the circumstances of the limitations and their relationship to the results of this original research. In some cases, efforts intended to mitigate the effects of the limitation are noted.

Beginning with the Literature Review, the number of peer-reviewed articles that illustrate how fire department Incident Commanders can use maps that identify critical locations to improve their decision-making at large-scale emergencies was extremely limited. As a result, the researcher made certain generalizations from the literature describing how emergency management practitioners use this information. Ideally, relevant academic literature and examples from the fire service would be reviewed.

Next, there are limitations to interviews. The researcher recognizes that a subject's responses depend on his or her integrity and understanding of the interview topic. In an effort to reduce error, the interview respondents were chosen based on their professional experience and job position, the purpose of this research and the interviews were clearly communicated, and the questions asked were provided in advance to allow the respondents time to prepare their answers. Additionally, statements included in this project and attributed to a subject who provided his or her answers verbally instead of in writing were asked to review and approve the statements prior to the completion of this ARP (see Appendix C for this documentation).

Perhaps the most significant limitations associated with this research are related to the data collection process used to identify the locations at DAL. The collection process was vulnerable to two types of errors: an error in the categorization of the location type, and the error of omission (simply not identifying a building).

The GIS Specialist identified the majority of the addresses for the foundation map during a windshield survey of the airport campus in the summer months of 2013. Then, the researcher used these addresses to search DFR fire and life safety records (TIS books and Firebase); both of these data sources may have addresses that are outdated and have not been updated. This could have lead to inaccuracies in the categorization of locations. In order to err on the side of caution, all addresses labeled as tactically significant in the DFR TIS books or as a permit holder for hazards from Firebase were labeled as special hazards. Similarly, all aircraft hangars were labeled as special hazards because of their potential to have fuel and highly combustible materials inside.

It is possible that some structures on the airport have not been identified during this process. The aerial photo used for the foundation map is several months old and DAL is undergoing constant construction to prepare for the increase in air traffic and travelers that will accompany the repeal of the Wright Amendment. Preferably, the researcher would have verified all addresses and each building's use would have been confirmed. However, security restrictions severely limit access to certain buildings and non-emergency driving around the airfield is discouraged during the busy daylight hours of the airport's operation. Given these limitations, the researcher was satisfied with the information given by the Airside Operations Manager and the Operations Training Coordinator regarding the hazardous and security sensitive locations on campus.

Finally, researchers in many disciplines recognize that there are limitations associated with being an “insider” researcher (Hanson, 1994; Hofmeyer, Scott, & Lagendyk, 2012). The dilemma associated with being an insider researcher is inherent in all applied research projects. There is value in recognizing the advantages - a greater understanding of context and relationships in an organization, for example, and the disadvantages – the potential to lose the objective perspective, of this researcher position (Adriansen & Madsen, 2009). Being an insider can impact the validity of data, especially qualitative information like interviews. Acknowledging this, measures were taken throughout this research process to ensure transparency and professionalism, and all procedures were documented and described in detail to allow for replication.

Results

The procedures used for this project led to a number of findings related to the five research questions that were the foundation of this ARP. The literature review provided support and direction for the design of the CRASH Map. The data collection process drew on multiple sources and resulted in the identification of over 150 addresses at DAL. Finally, personal communication was used to describe the background of the research problem, to answer the research questions, and to supplement and corroborate the addressing and categorization of locations at the airport. The results of this entire process have been divided according to research question and are described below.

What types of locations should be identified as infrastructure, resources, assets, and hazards and included on a map to help Incident Commanders during large-scale emergencies?

The answer to this research question is based on many factors. The literature reviewed named a number of location types that should be identified as part of the emergency management planning process. It also indicated that there are important political and ethical considerations that impact the classification of critical infrastructure and key resources, and these forces affect communities differently.

Federal guidelines concentrate on identifying critical infrastructure and insist that those systems and structures that are the most vulnerable and/or the most essential be identified first. Following that, communities should focus on locations that have been impacted by past events, especially those affected by natural disasters. Likewise, locations that involve life-safety concerns should be a priority. Facilities that can be used to support emergency operations and recovery, like gathering, sheltering, staging, and supply drop locations should then be identified before an emergency occurs. Area hazards should be recognized in advance as well; hazardous materials locations, fuel farms, terrain features and bodies of water can impact the rescue and incident stabilization phases of an event. Finally, certain agencies should identify and map locations that have operational or tactical significance, like fire hydrants, draft sites, and access roads.

The location types identified by the literature review were used as a guide and the critical infrastructure locations at DAL and bordering the airfield were plotted on the CRASH Map first. These locations included the Airport Emergency Operations Center and Air Traffic Control Tower, the Bachman Water Treatment Plant, and the light rail passenger train and freight rail train tracks. Bachman Lake was added as a special hazard because it is less than 800 meters

from the ends of two runways at DAL and can also be used as a draft site if the municipal water supply is interrupted. The locations that are labeled as fire/rescue assets were also added at this time: fire hydrants, access gates, and fire stations.

Next, personal communication with airport personnel and DFR battalion chiefs revealed a number of sites that should be identified to ensure the safety and effectiveness of DFR's emergency response to DAL. Sergeant Beattie was the first to notify the researcher about locations on the airfield that require specialized security because of either the tenant/owner or the contents. These locations are marked as special hazards and the Map notes will[2] be modified to prompt the Incident Commander to contact airport security for an emergency involving one of these special addresses.

The Airside Operations Manager and Airport Training Coordinator both described locations specific to DAL that are critical because of life safety concerns or because they influence the airport's continuity of operations. They helped identify the gas, fuel, and electric services to the terminal and Air Traffic Control areas that were added to the CRASH Map. Similarly, they emphasized responders should consider all hangars to have fuel and aircraft inside, until it is confirmed otherwise. Considering this, all hangars have been marked as special hazard locations. It was also stressed that one hangar and maintenance location contains extremely hazardous building materials and they have asked DFR to deny entry to all responders, even in the event of an emergency at this location. This particular site has been identified on the CRASH Map and the map symbol indicates that is slated to be demolished.

Chief Meador's responses indicated that, as the Incident Commander at DAL during a large-scale emergency, he is most likely to use a map to identify emergency traffic routes and

[2] On the maps that will be distributed to DFR battalion and deputy chiefs, the security sensitive addresses have been marked with an asterisk and a note to "Contact Airport Security"

safe refuge areas. He noted access roads, potential staging areas for emergency apparatus and safe areas for victims, as well as fire hydrants and fire department connections on his list of items that he would like to see marked on a map of DAL. Correspondingly, the patrol road has been marked on the CRASH Map and the various parking lot locations have been marked as resources, indicating that they may be appropriate staging and safe refuge areas.

Chief Creager identified many of the same firefighting-related concerns as Chief Meador. However, his responses gave more detail regarding the types of structures that are located at DAL. For instance, he is concerned about the locations of fuel farms, fueling stations (called fuel cabinets on the CRASH Map), paint booths, and target hazards. He would also like to see grid lines, taxiways, and runways marked on a map to help him identify locations, staging positions, and safe routes.

What are the advantages of identifying and mapping infrastructure, resources, assets, and hazards?

The literature that was reviewed to answer this question revealed that there are many advantages to identifying and mapping critical locations. Specifically, the research shows that this process supports the planning and response phases of emergency management. And, both DFR battalion chiefs confirm that they would use the map as a tool to improve the planning and response phases.

Maps can be useful during the planning phase of disaster preparedness. They can give a visual depiction of interdependencies and the potential for cascading events. In several different areas of the CRASH Map, one can see clusters of critical infrastructure and visualize the potential effects of an explosion, plane crash, or fire in the area. Along those same lines, in his

written responses, Chief Creager noted that he would use the CRASH Map to identify exposure problems. The proximity of the water treatment plant, Bachman Lake, and the rail lines are remarkable, too; structural damage or interruptions at these locations could seriously impact the commerce and infrastructure in the city of Dallas.

The literature shows that these types of maps can spark dialogue about critical infrastructure protection and can encourage mitigation efforts. The researcher found this to be true throughout the research process. For instance, almost every conversation regarding the background and purpose of this project required the researcher to begin with a basic definition of critical infrastructure and a description of the *National Infrastructure Preparedness Plan*.

Research and practice indicates that maps can be used to document and preserve local knowledge about an area. This was evidenced by the conversations with Sergeant Beattie, and the Airside Operations Manager and Airport Training Coordinator. For example, the Airport Training Coordinator recalled an electric vault fire that occurred years ago at DAL. Consequently, the two “manhole” access points and the main electrical vault were marked as special hazards. Their specialized knowledge of DAL contributed to the identification of critical locations on the CRASH Map.

Existing research describes how maps can support informed decision-making and situational awareness among responders. DFR Battalion Chief Meador noted that if a CRASH Map were available to all responding companies, there would be much less confusion during an emergency incident. He further explained that the details about entry and access, and building contents and hazards, would be identified on the map for everyone to see and understand prior to arrival. His comments allude to what has been described in detail by the research: maps reduce the possibility of miscommunication.

What challenges arise when the locations of infrastructure, resources, assets, and hazards are identified and mapped?

The research reviewed to answer this question revealed that there are several challenges associated with identifying and mapping critical locations. Most of the concerns apply to the data collection and map design processes. In general, the researcher experienced many of the difficulties noted here.

The available research documents that emergency planners often have difficulty deciding what locations to include. Researchers recognize that they also have difficulty categorizing locations and assigning value or priority. The researcher found both conclusions to be correct, even while deciding what to include on a specialized, context-driven map designed to aid fire department Incident Commanders. It was the goal of this project to include every address that is located at DAL, and there were many locations that were difficult to categorize. As a result, some locations were given two categories. For example, rental car locations were assigned to the categories of general use and special hazards because the locations are not operationally significant, but they do have gasoline fuel pumps on-site that are special hazards. In these instances, the primary use category was listed first. Similarly, Bachman Water Treatment Plant was labeled as a Hazard/Infrastructure because it contains large quantities of hazardous chemicals that are used for the water treatment, but it also represents a critical infrastructure location for the city of Dallas. A complete list of the DAL locations can be found on the Map Key (Appendix H).

Additionally, it is widely recognized in the literature and federal guidelines that there is difficulty associated with accessing details about critical infrastructure. Personal communication with both Ms. Magee and Mr. Perriott indicated that this has been their experience as well. This

challenge is correlated to the more general problem of critical infrastructure information security. Throughout this process, DFR GIS Specialist Spray emphasized the overall importance of information protection, and she described the complex network security and access restrictions that protect the GIS data. Likewise, Sergeant Beattie reported specific locations that require heightened physical security and information protection at DAL, and as a result, only the addresses and occupancy type are listed on the Map Key, so as to protect the identities of sensitive locations.

Finally, the literature used to answer this research question indicates that mapmakers are challenged to identify standardized symbols that will support understanding among users. A legend has been included on the CRASH Map to help users understand what each symbol means. Some symbols and colors, like the ones for the fire hydrants, are standard for DFR; the colors represent a certain water main size.

What infrastructure, resources, assets, and hazards exist at Dallas Love Field Airport?

Several different sources of data were used to identify the types of infrastructure, resources, assets, and hazards that exist at DAL. The results contributed to the mapping and classification of more than 150 addresses at the airport. The majority of occupancies were labeled as special hazards, primarily because of the potential to contain aircraft, fuel, or finishing equipment. Most of the critical infrastructure and key resources are clustered together, near the middle of the airport campus and between the two primary runways. However, some critical systems like the water treatment facility, the railroad and light rail, and the gas, fuel, and electric lines are located closer to the perimeter. Finally, the majority of the fire rescue assets are access gates and hydrants.

All of the locations are identified on the CRASH Map (Appendix G). The Map Key (Appendix H) can be used to find details about each location. For ease of use, the Map Key will be printed on the back of the CRASH Map. This Map and Map Key represents the final product of this original research project.[3]

How can Incident Commanders use a map identifying infrastructure, resources, assets, and hazard locations at Dallas Love Field Airport to formulate incident priorities and make operational decisions?

According to the literature reviewed for this project, there are a variety of ways that emergency managers can use a map that identifies critical locations. This information was used to make generalizations about how fire department Incident Commanders could utilize a map like this during large-scale emergencies. Importantly, statements from both DFR battalion chiefs support these generalizations.

Existing literature explains how maps of critical locations can be used to pre-plan areas and develop protection priorities before an event occurs. Chief Meador and Chief Creager recommended that the CRASH Map be used to pre-plan hazards at DAL. Specifically, Chief Meador would like to see emergency operations personnel visit the sites in advance, and document their surveys in a way that could be accessed later in the event of an emergency. He also described the advantage of having this information in advance of a disaster event, by saying that the CRASH Map would "allow the Incident Commander to set priorities and develop objectives for the incident prior to arriving on scene" (M. Meador, personal communication,

[3] It should be noted that the map is printed on a 8.5" by 11" standard piece of paper here, however 11" by 17" prints of the CRASH Map have been laminated for use by DFR emergency responders.

February 25, 2014). Similarly, Chief Creager emphasized the importance of size-up and responded that he would use the CRASH Map to begin a mental size-up while en route to DAL.

Chief Creager also described how the CRASH Map can support his decisions as an Incident Commander. He noted that the Map can help him determine "access points, staging locations, rehab locations, specific hazard locations, evacuation routes, exposure problems, water supply … [and] apparatus placement," during an emergency at DAL (A. C. Creager, personal communication, February 26, 2014). His statements coincide with the literature that suggests maps help leaders make choices about resource allocation and incident priorities.

Importantly, Chief Meador's interview described how he could use the map to communicate information to others. This type of use is documented in detail in the literature that was reviewed for this project. Researchers note that miscommunication often plagues the early phases of a disaster response, and that decision-makers can use maps to reduce confusion and help develop a common operating picture amongst responders.

Relatedly, Ms. Magee mentioned that the usefulness of the CRASH Map can depend on many factors during an actual emergency. Primarily, if the map has not been incorporated into daily use by DFR Incident Commanders, or if the map does not identify information relevant to the incident at hand, it is not likely to be used during the initial phases of emergency response. The research reviewed here matches her assessment.

Discussion

Currently, DFR Incident Commanders and responders lack the detailed and organized information about critical locations at DAL that is necessary for effective emergency response (A. C. Creager, personal communication, February 26, 2014; M. Meador, personal communication, February 25, 2014). Therefore, the intent of this research was to increase

emergency preparedness in the city of Dallas by identifying and mapping infrastructure, resources, assets, and hazard locations at the Love Field Airport. The protection of DAL is vital to the well-being of the city; the airport supports the financial health of the Metroplex, it employees thousands of workers from Dallas and the surrounding suburbs, and it provides commercial, corporate, and general aircraft services to more than seven million people every year. Unfortunately, it is vulnerable to many different types of disaster, including weather, terrorist, and aircraft emergencies, and the effects of a crisis at DAL may impact the surrounding neighborhoods, the air and rail transportation systems, and the infrastructure that Dallas depends on.

Two specific conclusions, supported by the existing literature and several federal guidelines, provided the foundation for this ARP: (a) identifying critical infrastructure, systems, and sites is an essential part of emergency management, and (b) maps are tools that can be used to supplement emergency preparedness and response planning. Five questions were designed to focus the action research process for this project. Ultimately, the results of this ARP defined the types of locations at DAL that DFR Incident Commanders can use to improve their decision-making at large-scale emergencies. The final product, the CRASH Map, depicts this information in a way that supports the development of a common operating picture and informed situational awareness among responders before and during an emergency. This research produced results that are significant to DFR, and this section describes the relationship between this project and the findings noted in the existing literature.

It is important to recognize that the practices of emergency management and preparedness and response planning vary considerably among communities. The dynamics of local government and the resources in each city are unique; these activities must be customized

to each municipality (DHS, n.d.; "Fact Sheet," n.d.; Lindell & Perry, 2007; Schafer et al., 2007). Therefore, it is reasonable for communities to have different priorities and areas of focus. Yet, the general findings of this research indicate that the conditions affecting the identification and mapping of critical locations in Dallas are similar to what is described in the literature.

For example, the data collection approach used for this ARP was sufficient to identify critical locations at DAL and aligned with the methods described in the current literature. Critical locations were identified using an asset-by-asset approach, and they were classified with the specific purpose of supporting DFR Incident Commanders and emergency response (DHS, n.d.). These methods correspond directly to the literature that describes how agencies can rank the significance of systems and sites and organize them differently based on context or specialty (Stanek et al., 2010).

Airport personnel and DFR battalion chiefs were interviewed regarding the types of locations that should be identified as critical and included on the CRASH Map. Their responses coincided with the types of locations that researchers and federal agencies recommend for identification and inclusion during the emergency planning process. Primarily, the airport personnel focused on locations and systems that are hazardous or impact the airport's continuity of operations, like utilities, air traffic control, maintenance and fuel farm sites. The DFR Incident Commanders concentrated on access points, safe areas for victims, and assets that impact fire department operations like fire hydrants (*Aircraft Rescue and Fire Fighting*, 2008; NFPA, 2014; NFPA, 2013; NFPA, 2010).

Overall, the advantages and challenges associated with identifying and mapping critical locations, as described in the literature, were supported by the findings of this project. However, some specifics warrant further discussion. The literature emphasized that the process of critical

infrastructure identification could spark dialogue about prevention and mitigation (Greenberg et al., 2011; McConnell & Drennan, 2006; Simonoff et al., 2011) and could also be used to document local knowledge (Tran et al., 2009; Turoff et al., 2004). Indeed, this process identified new information for DFR responders that can be used to improve pre-plans and response procedures at DAL. For instance, it is remarkable that the information regarding the high security hangars and the location of the airport's emergency operations center had not been documented or communicated to the battalion chiefs that are first due as Incident Commanders to DAL. Similarly, other critical locations like the manhole access to electrical vaults and the airport's triturator were identified. These locations were all included on the CRASH Map.

Perhaps the most significant finding of this research stemmed from the personal conversations between the researcher and others. Throughout the data gathering process, one fact became clear: the majority of people who were contacted regarding the content of this project did not understand the definition of critical infrastructure or appreciate the concept of critical infrastructure protection. Could this be a result of poor communication and information-sharing practices amongst the emergency preparedness community, as described in the current literature? Or, are municipal resources being consumed by what may be more pressing matters like emergency response and daily fire protection duties? Fire departments are still considered, by many, to be *response* organizations, and the mission of planning and prevention is not universally accepted.

There are significant implications for DFR, based on these research findings. Federal guidelines and emergency management research indicates that local agencies, including the emergency services, should be involved in planning and preparing for critical infrastructure protection. The final product of this research, the CRASH Map, is a tool that can be used to

identify critical locations, pre-plan their hazards, and designate response procedures that will minimize the impact of an emergency at DAL. Ideally, this information can support the triage of structures and areas during the early phases of a disaster when resources are inadequate to address every concern. The findings presented here document the advantages associated with planning for critical infrastructure protection, and they also suggest that DFR and the city of Dallas are largely unfamiliar with the process.

DFR and the city of Dallas are not unique in this aspect. It has been noted in the literature that considerable challenges exist to the information-sharing requirements of the *National Infrastructure Protection Plan*. In short, the organizations that hold critical infrastructure information are not convinced that the benefits to sharing the details outweigh the risks of disclosure. Furthermore, it seems that the fire service, in general, has yet to identify its role when it comes to planning for critical infrastructure protection; this is evidenced in one major way by the scarcity of published work on the topic.

Recommendations

This ARP was designed to describe how the identification and mapping of critical locations can improve emergency preparedness in the city of Dallas. The research presented here described the advantages and challenges associated with these activities and suggested that local agencies, like fire departments, are not experienced in evaluating critical infrastructure locations and prioritizing protection and mitigation efforts. This research can provide an impetus for change among fire departments that relates to planning for critical infrastructure protection.

The CRASH Map was developed so that DFR Incident Commanders can have access to information that will support situational awareness and decision-making during an emergency at the Dallas Love Field Airport. The remainder of this section describes recommendations that

can support similar planning and response activities and will improve emergency preparedness in Dallas. Based on the results of this project, the researcher's recommendations are:

- So as to support the mission of the Department of Homeland Security, DFR should increase its organizational understanding of the federal Critical Infrastructure Protection (CIP) Programs
- So as to contribute to the USFA's Strategic Goals, DFR should recognize that identifying and mapping critical infrastructure, resources, assets, and hazards increases local emergency planning and preparedness
- So as to receive guidance and information on participating in CIP programs, DFR should engage the assistance of the Texas Department of Public Safety
- So as to protect Dallas' critical infrastructure, DFR should initiate dialogue and develop systems for critical infrastructure information-sharing among public and private sector organizations
- So as to improve its ability to achieve the Department's mission of providing the citizens of Dallas "the most effective and rapid emergency, fire, rescue, and prevention services in an ever-changing environment," (www.dallasfirerescue.com) DFR should develop a program to identify and protect systems and structures that are essential to the well-being of the city of Dallas
- So as to support the development of a such a program, DFR should become familiar with the advantages described in this research

- So as to anticipate the obstacles and difficulties that accompany programs designed to identify and protect systems and structures, DFR should plan to address the challenges described in this research
- So as to make immediate improvements in pre-planning and emergency response activities, DFR Incident Commanders should utilize the CRASH Map to learn more about the locations of critical infrastructure, resources, assets and special hazards at DAL

Future fire service researchers have a number of opportunities to address a gap in the scientific literature by pursuing research related to securing local assets and systems against natural and human-caused crises. Further study is necessary in order to document and describe the ways that fire-rescue departments can contribute to critical infrastructure protection. Prospective researchers should investigate the types of resources that are required to develop and maintain a critical infrastructure protection program. There are examples of robust CIP systems throughout the nation and colleagues are encouraged to examine how fire-rescue departments participate in these programs. Finally, DFR members are urged to use this research to investigate the equipment, personnel, and training that are required to ensure their capabilities to respond effectively to a large-scale emergency at DAL.

References

Adriansen, H. K., & Madsen, L. M. (2009). Studying the making of geographical knowledge: The implications of insider interviews. *Norwegian Journal of Geography, 63*, 145-153. http://dx.doi.org/10.1080/00291950903238966

Aircraft rescue and fire fighting (5th ed.). (2008). Stillwater, OK: Fire Protection Publications.

Airport impact analysis/master plan: Dallas Love Field [Executive summary]. (n.d.). Retrieved from Dallas Love Field Airport website: http://www.dallas-lovefield.com/pdf/ExecutiveSummary.pdf

Auerswald, P., Branscomb, L. M., LaPorte, T. M., & Michel-Kerjan, E. (2005). The challenge of protecting critical infrastructure. *Issues in Science and Technology*, 77-83. Retrieved from http://opim.wharton.upenn.edu/risk/downloads/05-11-EMK.pdf

Badham, R. J., & Sense, A. J. (2006, December). Spiralling up or spinning out: A guide for reflecting on action research practice. *International Journal of Social Research Methodology, 9*(5), 367-377. http://dx.doi.org/10.1080/13645570600659540

Barry, J. M. (1994, December). The crash of US Air Flight 1016: Emergency preparedness. *Journal of Environmental Health*, *57*(5), 8-11.

Batey, A. (2012, June 4). On the map. *Aviation Week & Space Technology*, *174*(20), 76.

Bianchetti, R. A., Wallgrun, J. O., Yang, J., Blanford, J., Robinson, A. C., & Klippel, A. (2012, November). Free classification of Canadian and American emergency management map symbol standards. *The Cartographic Journal*, *49*, 350-360. http://dx.doi.org/10.1179/1743277412Y.0000000022

Boeing Commercial Airplanes. (2006). *Statistical summary of commercial jet airplane accidents: Worldwide operations 1959-2005*. Seattle, WA: Author.

Budic, Z. D. (1994, Spring). Effectiveness of geographic information systems in local planning. *Journal of the American Planning Association, 60*(2), 244-263.

CNN Money. (2012). *Fortune 500 Companies* [Data table]. Retrieved from money.cnn.com

Carpignano, A., Golia, E., DiMauro, C., Bouchon, S., & Nordvik, J. (2009, April-June). A methodological approach for the definition of multi-risk maps at regional level: First application. *Journal of Risk Research, 12,* 513-534. http://dx.doi.org/10.1080/13669870903050269

Chatterjee, S., & Abkowitz, M. D. (2011). A methodology for modeling regional terrorism risk. *Risk Analysis, 31*(7), 1133-1140. http://dx.doi.org/10.1111/j.1539-6924.2010.01565.x

Chen, R., Rao, H. R., Sharman, R., Upadhyaya, S. J., & Kim, J. (2010, March). An empirical examination of IT-enabled emergency response: The cases of hurricane Katrina and hurricane Rita. *Communications of the Association for Information Systems, 26,* 141-156.

Chen, R., Sharman, R., Rao, H. R., & Upadhyaya, S. (2007). *Design principles for critical incident response systems*. Retrieved from Springer-Verlag website: http://link.springer.com/article/10.1007%2Fs10257-007-0046-0

Choobineh, J., Dhillon, G., Grimaila, M. R., & Rees, J. (2007). Management of information security: Challenges and research directions. *Communications of the Association for Information Systems,* 20, 958-971.

Chua, A. Y., Kaynak, S., & Foo, S. S. (2007, February 1). An analysis of the delayed response to hurricane Katrina through the lens of knowledge management. *Journal of the American Society for Information Science and Technology*, *58*(3), 391-403. http://dx.doi.org/10.1002/asi.20521

Comprehensive preparedness guide 201: Threat and hazard identification and risk assessment. (2013). Retrieved from Federal Emergency Management Agency website: http://www.fema.gov/media-library-data/8ca0a9e54dc8b037a55b402b2a269e94/CPG201_htirag_2nd_edition.pdf

Corbane, C., Carrion, D., & Broglia, M. (2011). Development and implementation of a validation protocol for crisis maps: Reliability and consistency assessment of burnt area maps . *International Journal of Digital Earth*, 1(Supplement 1), 8-24. http://dx.doi.org/10.1080/17538947.2010.512153

Dallas Convention and Visitors Bureau website. (n.d.). www.visitdallas.com

Dallas Economic Development website. (2012). www.dallas-ecodev.org

Dallas history. (2002). Retrieved from http://www.dallashistory.org/history/dallas/dallas_history.htm

Department of Homeland Security. (n.d.). *Supplemental tool: Executing a critical infrastructure risk management approach*. Retrieved from Department of Homeland Security website: http://www.dhs.gov/sites/default/files/publications/NIPP%202013%20Supplement_Executing%20a%20CI%20Risk%20Mgmt%20Approach_508.pdf

DerHohannesian, A., & Kreckle, J. (2011, July). A lasting impact of 9/11. *Airport Business*, 9-11. Retrieved from www.airportbusiness.com

Dickens, L., & Watkins, K. (1999, June). Action research: Rethinking Lewin. *Management Learning*, *30*(2), 127-140.

Dimova, S. (2010). *The role of geoinformation in disaster management* [Professional paper]. Retrieved from American Society for Photogrammetry and Remote Sensing: http://www.asprs.org/a/publications/proceedings/reno2006/copyrght.pdf

Doody, O., & Noonan, M. (*20*13). Preparing and conducting interviews to collect data. *Nurse Researcher*, 20(5), 28-32.

Executive analysis of fire service operations in emergency management - Student manual (3rd ed.). (2012). Emmistburg, MD: United States Fire Administration.

Fact sheet. (n.d.). *Emergency Management & Response - Information Sharing & Analysis Center*.

Federal Aviation Administration. (2012). *Terminal area forecast summary, Fiscal years 2012 - 2040*. Retrieved from http://www.faa.gov/about/office_org/headquarters_offices/apl/aviation_forecasts/taf_reports/media/TAF_summary_report_FY2012.pdf

Federal Aviation Administration. (2013). *CY 2012 Passenger enplanements at all U.S. airports* [data file]. Retrieved from www.faa.gov

Federal Aviation Administration. (2013). *Commercial service airports based on CY2012 enplanements* [Data file]. Retrieved from www.faa.gov

Fourcade, M. (1968). *L'arche de Noe*. Paris: Fayard.

Fox, W. (2011, June 1). Commanding map. *Armada International*, 37-40.

Furlong, J. N., Ajemian, G., & McPherson, T. (2003). *History of the Dallas Floodway*. Retrieved from United States Army Corp of Engineers website: http://www.swf.usace.army.mil/Portals/47/docs/PAO/DF/DallasFloodwayHistoryPaper.pdf

Gillman, T. J. (2009, December 9). Dallas-Ft.Worth area moves to top tier of terrorism targets. *The Dallas Morning News*. Retrieved from www.dallasnews.com

Green, L. V., & Kolesar, P. J. (2004, August). Improving emergency responsiveness with management science. *Management Science, 50*(8), 1001-1014. http://dx.doi.org/10.1287/mnsc.1040.0253

Greenberg, M. R., Lowrie, K., Mayer, H., & Altiok, T. (2011). Risk-based decision support tools: Protecting rail-centered transit corridors from cascading effects. *Risk Analysis, 31*(12), 1849-1858. http://dx.doi.org/10.1111/j.1539-6924.2011.01627.x

Hanson, E. J. (1994). Issues concerning the familiarity of researchers with the research setting. *Journal of Advanced Nursing, 20*, 940-942. http://dx.doi.org/10.1046/j.1365-2648.1994.20050940.x

Harrington, T. (2007, February 12). Area fire maps get high-tech overhaul: Moraga-Orinda: High-resolution photos identify roof materials, nearby hazards, en route to blaze. *Contra Costa Times*. Retrieved from http://www.contracostatimes.com

Hart, K. (2005, December). Inbox Journalism. *American Journalism Review*, 58-63. Retrieved from http://ajrarchive.org/Article.asp?id=4005

Hively, T. (2011). Dallas. In *Our States: Texas* (pp. 1-5). Toledo, OH: Great Neck Publishing.

Hofmeyer, A., Scott, C., & Lagendyk, L. (2012). Researcher-decision-maker partnerships in health services research: Practical challenges, guiding principles. *Health Services Research, 12*. http://dx.doi.org/10.1186/1472-6963-12-280

Jiang, X., Hong, J. I., Takayama, L. A., & Landay, J. A. (2004). Ubiquitous computing for firefighters: Field studies and prototypes of large displays for incident command. *Human-Computer Interaction Institute*. Retrieved from http://repository.cmu.edu/hcii/66

Johansson, B. J., Trnka, J., Granlund, R., & Gotmar, A. (2010). The effect of a geographical information system on performance and communication of a command and control

organization. *International Journal of Human-Computer Interaction*, *26*(2-3), 228-246. http://dx.doi.org/10.1080/10447310903498981

Johnson, L. A. (2012). It's in the numbers: Collecting injury and near-miss data can improve safety in the Dallas Fire-Rescue Department. Retrieved from http://www.lrc/fema.gov/starweb/lrcweb/servlet.starweb

Johnson, L. A. (2013). *Building a community injury profile: The first step toward a risk reduction program for the city of Dallas* (National Fire Academy). Retrieved from http://www.usfa.fema.gov/pdf/efop/efo47302.pdf

Leedy, P. D., & Ormrod, J. E. (2013). *Practical research: Planning and design* (10th ed.). Upper Saddle River, NJ: Pearson.

Lindell, M. K., & Perry, R. W. (2007). Planning and preparedness. In W. L. Waugh, Jr., & K. Tierney (Eds.), *Emergency management: Principles and practice for local government* (2nd ed., pp. 113-142). Washington, D.C.: International City/County Management Association.

Lisheron, M. (2013, April). The e-mail interview debate. *American Journalism Review*, 18-23. Retrieved from http://ajrarchive.org/Article.asp?id=5512

Mahaney, C. (1997). April 2, 1957: Dallas' date with disaster. Retrieved from http://www.stormtrack.org/library/historic/dal57.htm

Maxwell, D. (2006, February). Maps: Critical Response Tools. *Fire Engineering*, 101-103.

McConnell, A., & Drennan, L. (2006, June). Mission impossible? Planning and preparing for crisis. *Journal of Contingencies and Crisis Management*, *14*(2), 59-70.

McElhaney, J., & Hazel, M. V. (2013). Dallas, Tx. Retrieved from http://www.tshaonline.org/handbook/online/articles/HDD01

McEntire, D. A. (2002). Coordinating multi-organizational responses to disaster: Lessons form the March 28, 2000, Fort Worth tornado. *Disaster Prevention and Management, 11*(5), 369-379.

Mishra, V., Fuloria, S., & Singh Bisht, S. (2012). Enhancing disaster management by mapping disaster proneness and preparedness. *Disasters*, *36*(3), 387-397. http://dx.doi.org/10.1111/j.1467-7717.2011.01269.x

Morrow, B. H. (1999). Identifying and mapping community vulnerability. *Disasters*, *23*(1), 1-18.

National Fire Protection Association. (2010). *1620: Standard for pre-incident planning*. Retrieved from http://www.nfpa.org/codes-and-standards/document-information-pages?mode=code&code=1620

National Fire Protection Association. (2013). *402: Guide for aircraft rescue and fire-fighting*. Retrieved from http://www.nfpa.org/catalog/services/onlinepreview/online_preview_document.asp?id=40213#

National Fire Protection Association. (2013). *424: Guide for airport/community emergency planning*. Retrieved from http://www.nfpa.org/codes-and-standards/document-information-pages?mode=code&code=424

National Fire Protection Association. (2014). *403: Standard for aircraft rescue and fire-fighting services at airports*. Retrieved from http://www.nfpa.org/codes-and-standards/document-information-pages?mode=code&code=403

National Transportation Safety Board. (2000). *Emergency evacuation of commercial airplanes* (Safety Study NTSB/SS-00/01). Retrieved from http://www.ntsb.gov/doclib/safetystudies/SS0001.pdf

National infrastructure protection plan 2013: Partnering for critical infrastructure security and resilience . (2013). Retrieved from Department of Homeland Security website: http://www.dhs.gov/sites/default/files/publications/NIPP%202013_Partnering%20for%20Critical%20Infrastructure%20Security%20and%20Resilience_508_0.pdf

Netjasov, F., & Janic, M. (2008). A review of research on risk and safety modeling in civil aviation. *Journal of Air Transport Management, 14*, 213-220. http://dx.doi.org/10.1016/j.jairtraman.2008.04.008

Njotini, M. N. (2013). Protecting critical databases - towards a risk based assessment of critical information infrastructures (CIIS) in South Africa. *Potchefstroom Electronic Law Journal, 16*(1), 451-481. http://dx.doi.org/10.4314/pelj.v16i1.14

Office of the Secretary, Department of Homeland Security. (2006). *Procedures for handling critical infrastructure information* (6 CFR Part 29, RIN 1601-AA14). Retrieved from http://www.dhs.gov/xlibrary/assets/pcii_final_rule_federal_register9-1-06-2.pdf

Oliver, D. (2008, March). Multi-use mapping: Fire departments can play a key role in planning and developing a community's enterprise GIS database. *Fire Chief*, 78-81.

Phillips, M. (2011, December). Military mapping. *Military Technology*, 64.

Quigley, K. (2013, March). "Man plans, God laughs": Canada's national strategy for protecting critical infrastructure. *Canadian Public Administration*, *56*(1), 142-164.

Remembering the Dallas tornadoes of April 2, 1957. (n.d.). Retrieved from http://www.srh.noaa.gov/fwd/?n=dallastor50year

Riel, M. (2010). Understanding action research. Retrieved February 21, 2014, from http://cadres.pepperdine.edu/ccar/define.html

Santella, N., Steinberg, L. J., & Parks, K. (2009). Decision making for extreme events: Modeling critical infrastructure interdependencies to aid mitigation and response planning. *Review of Policy Research*, *26*(4), 409-422.

Schafer, W. A., Ganoe, C. H., & Carroll, J. M. (2007). Supporting community emergency management planning through a geocollaboration software architecture. *Computer Supported Cooperative Work, 16*, 501-537. http://dx.doi.org/10.1007/s10606-007-9050-7

Seeing the lay of the land: County's software exports digital and printable maps to users. (2008, August 1). *American City and County*. Retrieved from http://americancityandcounty.com/technology/gis_gps/seeing_lay_land_gis

Sheikhpour, H., Shirazian, G., & Safa, E. (2012). An approach on take-off and landing related aircraft accidents involving new considerations. In *International conference on traffic and transportation engineering* (Vol. 26, pp. 49-53). Singapore: IACSIT Press.

Simonoff, J. S., Restrepo, C. E., Zimmerman, R., Naphtali, Z. S., & Willis, H. H. (2011, May). Resource allocation, emergency response capability, and infrastructure concentration around vulnerable sites. *Journal of Risk Research*, *14*(5), 597-613. http://dx.doi.org/10.1080/13669877.2010.547257

Sproull, L. S. (1985). Using electronic mail for data collection in organizational research. *Academy of Management Journal*, *29*(1), 159-169.

Stanek, K., Friedmannova, L., Kubicek, P., & Konecny, M. (2010, December). Selected issues of cartographic communication optimization for emergency centers. *International Journal of Digital Earth*, *3*, 316-339. http://dx.doi.org/10.1080/17538947.2010.484511

Stewart, M. G., Netherton, M. D., Shi, Y., Grant, M., & Mueller, J. (2012). Probabilistic terrorism risk assessment and risk acceptability for infrastructure protection. *Australian Journal of Structural Engineering, 13*(1), 1-17.

Subplan 1B: Fallen aircraft. (2003). In *City of Dallas Master Emergency Operations Plan: Accidental disaster plans* (Vol. 1, pp. 1-9).Dallas, TX: City of Dallas

The White House Office of the Press Secretary. (2013, February 12). *Presidential Policy Directive -- Critical infrastructure security and resilience* [Press release]. Retrieved from The Whitehouse website: http://www.whitehouse.gov/the-press-office/2013/02/12/presidential-policy-directive-critical-infrastructure-security-and-resil

Thompson, K. M., Rabouw, R. F., & Cooke, R. M. (2001, December). The risk of groundling fatalities from unintentional airplane crashes. *Risk Analysis, 21*, 1025-1037.

Tornado History Project. (n.d.). *Tornadoes in Dallas County, Texas* [Data file and map]. Retrieved from www.tornadohistoryproject.com

Tran, P., Shaw, R., Chantry, G., & Norton, J. (2009). GIS and local knowledge in disaster management: A case study of flood risk mapping in Viet Nam. *Disasters, 33*(1), 152-169. http://dx.doi.org/10.1111/j.0361-3666.2008.01067.x

Turoff, M., Chumer, M., Van de Walle, B., & Yao, X. (2004). The design of a dynamic emergency response management information system (DERMIS). *Journal of Information Technology Theory and Application, 5*(4), 1-35.

United States Census Bureau. (2012). *American Community Survey 1-year estimates* [Population Census]. Retrieved from factfinder2.census.gov

United States Census Bureau. (2012). *State & County QuickFacts* [Population Estimates]. Retrieved from http://quickfacts.census.gov/

United States Fire Administration. (n.d.). *United States Fire Administration: America's fire and emergency services leader - Strategic plan fiscal years 2010-2014*. Retrieved from http://www.usfa.fema.gov/downloads/pdf/strategic_plan.pdf

United States Government Accountability Office. (2006). *Information sharing: DHS should take steps to encourage more widespread use of its program to protect and share critical infrastructure information* (GAO-06-383). Washington, DC: Government Printing Office.

Van de Walle, B., & Turoff, M. (2008). Decision support for emergency situations. *Information Systems and E-Business Management*, *6*, 295-316. http://dx.doi.org/10.1007/s10257-008-0087-z

Veillette, P. (2010, May). When the sirens sound. *Business & Commercial Aviation*, *106*(5), 52.

WalkScore. (n.d.). www.walkscore.com/TX/Dallas

Wood, M. L. (2011, May 1). The strategy of mapping. *Engineer*, *41*(2), 22-24.

Wright, L. (2014). 2013 Homeland Security Grant Program summary. Retrieved from http://urbanareas.org/blog/2013-homeland-security-grant-program-summary/

Zupan, R., Sruk, D., & Franges, S. (2012). Experiment for determination of map graphics segment standard for handheld crisis maps management. *Technical Gazette*, *19*(4), 917-921. http://dx.doi.org/UDC/UDK 528.93:65.011.3

Appendix A

Action Steps	Activities	Persons Involved	Timeline	Resources Needed	Evaluation
1. Submit ARP Proposal	1. Perform preliminary research about topic 2. Develop research problem, purpose, research questions, and research method 3. Submit proposal	1. Researcher 2. Evaluator	Sept. - Oct., 2013	1. Computer 2. Internet access 3. Library/Online database access	1. Will the research questions yield answers that can help improve the stated problem? 2. Submitted Nov. 13, 2013 3. Received comments 4. Made recommended changes
2. Conduct Literature Review	1. Read existing literature related to: mapping, G.I.S., emergency planning, aircraft disasters, critical infrastructure, key resources, tactical hazards, tactical planning, CIKR protection plans, disaster response, emergency response, resource allocation	1. Researcher	Sept. - Dec., 2013	1. Computer 2. Internet access 3. Library/Online database access 4. City of Dallas Emergency Operations Plans 5. NFPA Standards 6. Federal Plans	1. At least 8 references cited
3. Gather Data	1. Interviews 2. Identify addresses 3. Field Surveys 4. DFR Inspection Records - Firebase system search 5. DFR Tactical Information Records - system search	1. DHS Protective Security Advisor 2. DAL Airside Operations Manager & DAL Training Coordinator 3. DFR G.I.S. Specialist 4. Researcher	Jan. 2014	1. Schedule interview appointments 2. Schedule field survey drive times 3. DFR Intranet Computer for Firebase search 4. DFR Tactical Information Survey	1. Addresses identified 2/9/14 2. DHS interview 2/10/14 3. T.I.S. Manuals surveyed 2/12/14 4. DFR Inspection records surveyed 2/12/14 5. GIS meeting 2/18/14 6. DAL meeting 2/19/14
4. Write ARP	1. Organize information	1. Researcher	Jan. 2014	1. Computer 2. APA Manual 3. Literature References 4. Data gathered	1. Outline completed Jan. 2014
5. Develop CRASH Map	1. Meet with G.I.S. staff 2. Compile data 3. Determine symbols 4. Create map	1. Researcher 2. Meet with G.I.S Staff	Jan. 2014	1. Computer 2. G.I.S./mapping software	1. E-mail correspondence throughout Jan. 2014 2. First meeting 2/18/14 3. Evaluate draft on 2/21/14 4. 2nd draft Meeting 2/24/14

Appendix B

From: Berry, Mark Sent: Thu 2/27/2014 10:42 AM
To: Johnson, Lauren
Cc:
Subject: FW: Number of Incidents in 2013?
Attachments: FY13 Yearend _ Performance Measures for Chief Berry.xlsx(236KB)

			Oct-12	Nov-12	Dec-12	Jan-13	Feb-13	Mar-13	Apr-13	May-13	Jun-13	Jul-13	Aug-13	Sep - 13
Total Incidents		Monthly	18015	17575	19585	18214	15714	18136	18143	19766	19317	19263	19668	18407
		Cumulative	18015	35590	55175	73389	89103	107239	125382	145148	164465	183728	203396	221803

Appendix C

From: Perriott, Harvey Sent: Wed 2/26/2014 7:26 PM
To: Johnson, Lauren
Cc: Perriott, Harvey
Subject: RE: follow-up on our lunch conversation re: critical infrastructure protection

Chief, please see below for corrections. Look for the ## to see what I'd change. I only made recommended changes to questions 1 & 4. Call or email if you have any more questions.

-----Original Message-----
From: Johnson, Lauren
Sent: Friday, February 21, 2014 2:56 PM
To: Perriott, Harvey
Subject: follow-up on our lunch conversation re: critical infrastructure protection

I'm in the final stages of my research paper and I have listed four excerpts below that I'd like your help with. Just to remind you, the purpose of my project is to create a map that identifies critical infrastructure, resources, assets, and hazards at Dallas Love Field Airport that fire department Incident Commanders can use to help make operational decisions in the event of a large-scale emergency.

Basically, I want to make sure that you agree with the statements that I have attributed to you, and we can address any concerns you may have. The parentheses indicate the sources I'm citing and I am not considering any of these statements as direct quotes, but rather a generalization of what we talked about at lunch. I've included several sentences just to give you the context.

Two asterisks indicate the beginning and end of the sentence that I would like you to look at.

1. Yet, it should be noted that literature specifically related to how fire department Incident Commanders can identify and use this information to make operational decisions was a priority for this review. However, only a very small number of peer-reviewed research articles related to this particular subject were found. **This may be due to the fact that the vast majority of critical infrastructure and key resource identification is being done at the national level, as required by federal directives, and many state-level operations are still in their infancy; integrating local emergency responders is still a few years to come** (H. Perriott, personal communication, February 10, 2014).

I wouldn't say most of the planning is done at the federal level. The federal government has the lead for providing guidance with respect to critical infrastructure protection (CIP) under the National Infrastructure Protection Plan. The concept of CIP as a formal program has only been around just under 10 years to coincide with the creations of DHS Office of Infrastructure Protection and the publishing of the original National Infrastructure Protection Plan in 2006.

Many states and local jurisdictions around the country have taken very aggressive moves to stand up strong CIP programs (NJ, CA, Houston and Tampa immediately come to mind). Unfortunately, due to the lack of an aggressive program here in Texas (at the state level 2006 - 2013), local jurisdictions in Texas have also been slow to implement strong programs. Another complicating factor may be the constant decline in city budgets making the addition of personnel to staff a CIP office impractical. ##

2. Research indicates that it is challenging for risk managers to decide what assets should be included on a risk map (Carpignano et al., 2009). Eighty-five percent of the critical infrastructure in the United States is privately owned (Auerswald, Branscomb, LaPorte, & Michel-Kerjan, 2005). **So, in some cases, critical infrastructure and interdependent systems can be hard to identify and information-sharing processes are poor or inaccessible** (Chatterjee & Abkowitz, 2011; H. Perriott, personal communication, February 10, 2014).

3. The subject of developing a map that identifies critical infrastructure, resources, assets, and hazards merits a discussion about how to maintain the security of the information that is represented on the map. Consider that the state of California partnered with DHS to label vulnerable critical infrastructure sites, but chose to list only the address, rather than the specific type of each facility (Simonoff et al., 2011). **In general, information security is becoming more and more challenging** (H. Perriott, personal communication, February 10, 2014; Njotini, 2013).

4. **The security concerns and the other challenges associated with identifying and mapping infrastructure, resources, assets, and hazards have contributed to the slow growth of the Critical Infrastructure Protection Plan at the national level** (H. Perriott, personal communication, February 10, 2014).

See my edits for question 1. We haven't been slow. We have provided guidance, albeit the guidance is constantly being refined/updated (we are on the third revision of the NIPP). The burden of identifying and mapping critical infrastructures still resides with states/jurisdictions as they will be the responding agencies.

In general, data issues dominate the related literature: how should organizations gather, store, update, and validate critical information? What information should be included and how can it be accessed and protected? Technical challenges to designing a map exist as well; mapmakers should use a common vocabulary and standardized symbology to ensure understanding.

Appendix D

From: Johnson, Lauren Sent: Sat 2/22/2014 11:02 AM
To: Magee, Lanita
Cc: Johnson, Lauren
Subject: Interview questions

Ms. Magee,

Thank you so much for agreeing to respond to a few questions regarding critical infrastructure protection at DAL. As you know, I am working on a project that will identify and map infrastructure, resources, assets, and hazards at DAL. This map can be used by DFR Incident Commanders during a large-scale emergency to visualize the extent of the incident, locate safe routes and staging areas, and to develop operational priorities.

With your permission, a copy of this e-mail and your responses will be included in the appendix of my research paper. However, all of your contact information will be redacted. The information your provide will contribute primarily to the Background and Significance portion of my project. For this paper, my focus is on improving emergency preparedness in the city of Dallas and the Background and Significance section describes our current state of operations as well as the area that I am working to improve.

Feel free to answer the questions in any manner you would like; you may call me, we can schedule a meeting, or you can respond directly to this e-mail. Please contact me with any questions or concerns that you have regarding this e-mail. Thank you very much for your time.

Best regards,
Lauren Johnson

1. Your professional experience includes emergency management roles at both the state and local levels. Are there particular challenges associated with emergency management activities and critical infrastructure protection at an airport?

2. What role should DFR play in planning for critical infrastructure protection at DAL?

3. Recently, DAL has conducted several emergency simulations to evaluate its disaster preparedness. As the Emergency Management Coordinator for the City of Dallas Aviation Department, you have had the opportunity to observe DFR during its response to these simulations. Given the wide range of emergencies that may occur (plane crash, active shooter, terrorist bombing or NBC attack, fuel fires, etc.), do you think that DFR's response and decision-making capabilities would be improved if a map like this were available? If yes, how so?

Appendix E

Monday, February 24, 2014, 14:00

Personal interview: Lanita Magee, Emergency Management Coordinator
City of Dallas, Department of Aviation

Transcript of written notes taken during the interview, by the researcher

1. Your professional experience includes emergency management roles at both the state and local levels. Are there particular challenges associated with emergency management activities and critical infrastructure protection at an airport?

- Specifically, the airports have different challenges because of the number of regulatory agencies that have oversight. There are federal, state, and local groups that all have regulations and requirements that we must comply with and that makes all activities more complicated.
- Additionally, airports are known to be targets for terrorists and other strange events. Maintaining security at DAL is a definite priority and the environment is constantly changing, requiring constant vigilance.

2. What role should DFR play in planning for critical infrastructure protection at DAL?

- The idea of critical infrastructure protection really is not currently being addressed at the city level, especially not within the Aviation Department. For us, it's a matter of identifying the most realistic risks and working to mitigate and prepare a response to those hazards. The majority of critical infrastructure is managed by the private sector, and we are operating with the understanding that they are taking measures to protect their own systems and structures. In general, our emergency planning is devoted to response activities, much in the same way DFR's is.

3. Recently, DAL has conducted several emergency simulations to evaluate its disaster preparedness. As the Emergency Management Coordinator for the City of Dallas Aviation Department, you have had the opportunity to observe DFR during its response to these simulations. Given the wide range of emergencies that may occur (plane crash, active shooter, terrorist bombing or NBC attack, fuel fires, etc.), do you think that DFR's response and decision-making capabilities would be improved if a map like this were available? If yes, how so?

- I think this would just be another tool in the tool box for IC's. If the timing is right and the disaster allows, I can see how it would be helpful. But, I also understand that during an emergency, ICs and responders can be over-loaded with information during the initial stages of an incident, and using any aids must have been practiced and become part of a routine, in order for them to be used correctly during a disaster.

Appendix F

10:00 a.m.

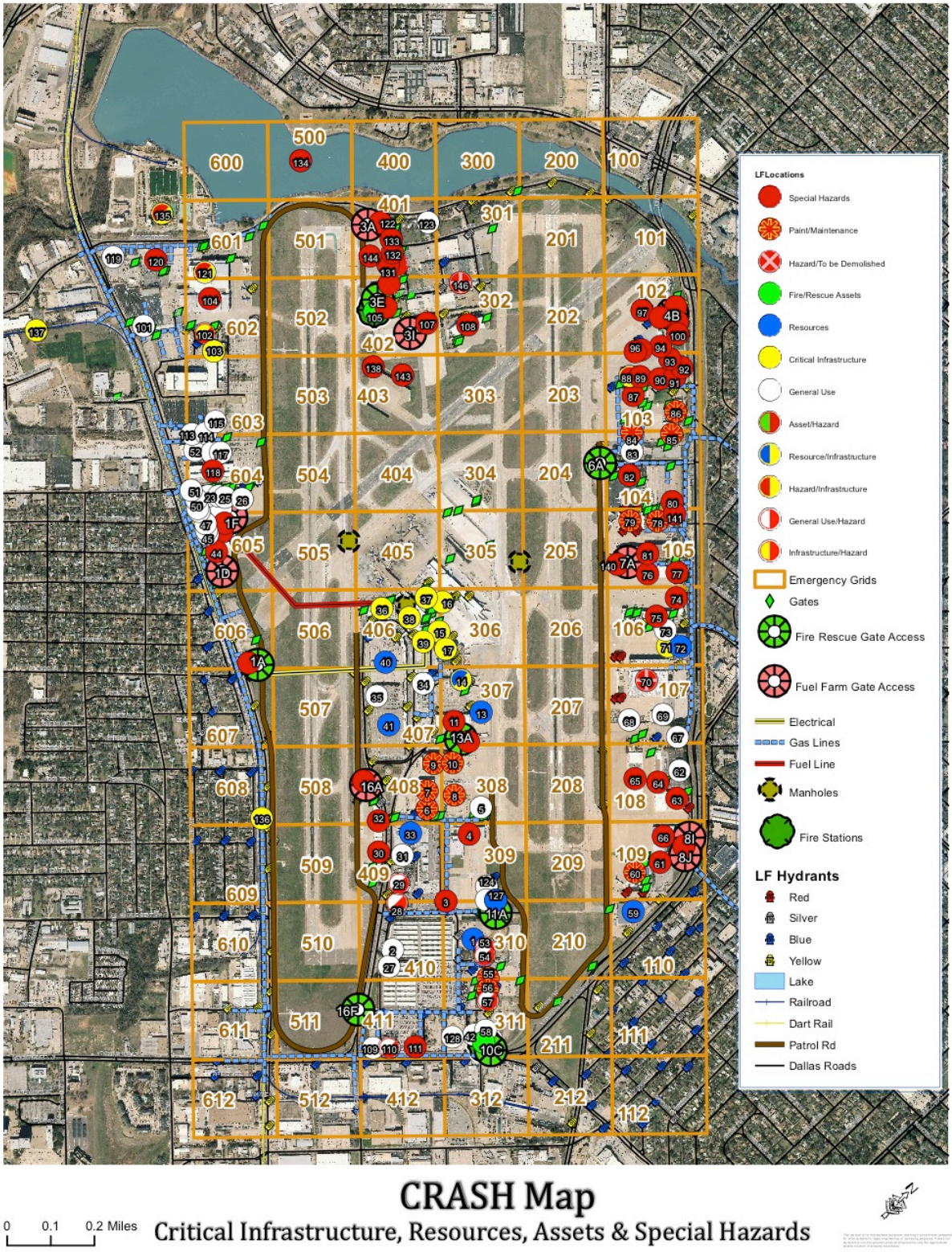
Thursday, February 5, 2014

Telephone interview: Sergeant Michael Beattie,
Dallas Police Department, Love Field Squadron

Transcript of written notes taken during the conversation, by the researcher

- Emergency access gates
- Meeting point for DPD escorts
- Hangars that belong to clients that are “sensitive” – politically and/or impact federal government security
- Storage building for ammunition and explosives for canine training

Appendix G


LFLocations
Special Hazards
Paint/Maintenance
Hazard/To be Demolished
Fire/Rescue Assets
Resources
Critical Infrastructure
General Use
Asset/Hazard
Resource/Infrastructure
Hazard/Infrastructure
General Use/Hazard
Infrastructure/Hazard
Emergency Grids
Gates
Fire Rescue Gate Access
Fuel Farm Gate Access
Electrical
Gas Lines
Fuel Line
Manholes
Fire Stations
LF Hydrants
Red
Silver
Blue
Yellow
Lake
Railroad
Dart Rail
Patrol Rd
Dallas Roads
CRASH Map
Critical Infrastructure, Resources, Assets & Special Hazards
0 0.1 0.2 Miles

Appendix H

Grid	#	Address	Grid	#	Address	Grid	#	Address
102	94	8611 LEMMON	307	13	7610 AVIATION	410	2	6900 AUBREY
102	95	8611 LEMMON	307	14	7710 AVIATION	410	27	6800 CEDAR SPRINGS
102	96	8611 LEMMON	308	5	7344 AVIATION	410	28	7020 CEDAR SPRINGS
102	97	8611 LEMMON	308	8	7440 AVIATION	411	109	3113 W MOCKINGBIRD
102	98	8611 LEMMON	308	10	7440 AVIATION	411	110	3127 W MOCKINGBIRD
102	99	8611 LEMMON	309	3	7106 AVIATION	411	111	3211 W MOCKINGBIRD
102	100	8611 LEMMON	309	4	7336 AVIATION	500	134	3500 NORTHWEST HWY
102	142	Fuel Farm/Cabinet	309	124	3355 TOM BRANIFF	601	121	2832 SHORECREST
103	86	8555 LEMMON	309	125	3351 TOM BRANIFF	602	102	2700 LOVE FIELD
103	87	8601 LEMMON	309	126	3398 TOM BRANIFF	602	103	2702 LOVE FIELD
103	88	8611 LEMMON	309	127	3399 TOM BRANIFF	602	104	2707 LOVE FIELD
103	89	8611 LEMMON	310	1	6828 ANSLEY AVE	603	113	2625 SEELCCO
103	90	8611 LEMMON	310	53	3377 EDWARDS	603	114	2717 SEELCCO
103	91	8611 LEMMON	310	54	3377 EDWARDS	603	115	2757 SEELCCO
103	92	8611 LEMMON	310	55	3387 HAWES	604	18	2715 BROOKFIELD
103	93	8611 LEMMON	311	42	6618 COLLVILLE	604	19	2719 BROOKFIELD
104	80	8209 LEMMON	311	56	3389 HAWES	604	20	2725 BROOKFIELD
104	82	8321 LEMMON	311	57	3407 HAWES	604	23	2722 BURBANK
104	83	8333 LEMMON	311	58	3410 HAWES	604	24	2734 BURBANK
104	84	8405 LEMMON	311	112	3333 W MOCKINGBIRD	604	25	2742 BURBANK
104	85	8411 LEMMON	311	128	6614 WADDELL	604	26	2750 BURBANK
105	76	8001 LEMMON	401	122	3250 SHORECREST	604	48	8502 DENTON
105	77	8001 LEMMON	401	123	3322 SHORECREST	604	49	8506 DENTON
105	78	8201 LEMMON	401	130	9299 WEISS	604	50	8512 DENTON
105	79	8201 LEMMON	401	131	9301 WEISS	604	51	8520 DENTON
105	81	8121 LEMMON	401	132	9309 WEISS	604	52	8650 DENTON
105	140	Fuel Farm/Cabinet	401	133	9415 WEISS	604	116	2730 SEELCCO
105	141	Fuel Farm/Cabinet	401	144	Fuel Farm/Cabinet	604	117	2732 SEELCCO
106	71	7777 LEMMON	402	105	3210 LOVE FIELD	604	118	2750 SEELCCO
106	72	7777 LEMMON	402	106	3226 LOVE FIELD	605	21	2734 BROOKFIELD
106	73	7777 LEMMON	402	107	3232 LOVE FIELD	605	22	2734 BROOKFIELD
106	74	8001 LEMMON	402	129	9215 WEISS	605	44	8350 DENTON
106	75	8001 LEMMON	403	138	Ammo Building	605	45	8414 DENTON
107	67	7555 LEMMON	403	143	Fuel Farm/Cabinet	605	46	8416 DENTON
107	68	7701 LEMMON	406	15	7920 AVIATION	605	47	8460 DENTON
107	69	7701 LEMMON	406	36	8008 CEDAR SPRINGS	606	43	8010 DENTON
107	70	7701 LEMMON	406	37	8008 CEDAR SPRINGS	608	136	DART Rail
108	62	7511 LEMMON	406	38	8008 CEDAR SPRINGS	Outside	101	2511 LOVE FIELD
108	63	7515 LEMMON	406	39	8008 CEDAR SPRINGS	Outside	119	2534 SHORECREST
108	64	7515 LEMMON	406	40	8025 CEDAR SPRINGS	Outside	120	2628 SHORECREST
108	65	7515 LEMMON	407	34	7750 CEDAR SPRINGS	Outside	135	2625 Shorecrest
109	60	7201 LEMMON	407	35	7801 CEDAR SPRINGS	Outside	137	Railroad
109	61	7205 LEMMON	407	41	8025 CEDAR SPRINGS			
109	66	7515 LEMMON	408	6	7440 AVIATION			Special Hazard
109	139	Fuel Farm/Cabinet	408	7	7440 AVIATION			
110	59	6911 LEMMON	408	9	7440 AVIATION			Critical Infrastructure
302	108	3250 LOVE FIELD	408	32	7367 CEDAR SPRINGS			
302	146	Vacant/Demo	408	145	Fuel Farm/Cabinet			Fire Rescue Assets
306	16	8100 AVIATION	409	29	7212 CEDAR SPRINGS			
306	17	8100 AVIATION	409	30	7363 CEDAR SPRINGS			Resources
307	11	7510 AVIATION	409	31	7366 CEDAR SPRINGS			
307	12	7610 AVIATION	409	33	7372 CEDAR SPRINGS			General Use

MAP KEY

Appendix I

From: Johnson, Lauren Sent: Sun 2/23/2014 8:57 AM
To: bc07c
Cc:
Subject: Chief Creager - Research Questions regarding DAL map

Chief Creager,

Thank you so much for agreeing to answer a few questions regarding your response, as a DFR Incident Commander, to a large-scale emergency at Dallas Love Field Airport.

To follow up on our phone call, I'd like to provide you with some background information. I am developing a map that identifies critical infrastructure, resources, assets, and hazards and DAL. This map will be the final product of an applied research project that is required for the Executive Fire Officer Program. The goal of my project is to improve emergency preparedness in the city of Dallas. Please answer these questions in any matter that you would like. You can respond directly to this e-mail or call me if you prefer; in either case, your answers can be informal. A copy of this e-mail will be included in the appendix of my project, and so will a summary of your responses. However, your contact information will not be listed (your e-mail addresses will be redacted). Please contact me if you have any questions or concerns.

1. As an Incident Commander, what types of information would you like to see on a map of Dallas Love Field Airport?

2. Currently, what DFR resources can you use to identify locations at DAL that are:

a) fire department resources, like hydrants and access gates?

b) assets that can support emergency operations, like the Airport EOC, DPD offices, areas suitable for staging and triage?

c) critical infrastructure that is vital to airport operations and the well-being of the city, like gas and electric utilities, and the ATC control tower?

d) special hazards, like hazmat containers, maintenance hangars, fuel farms, biohazard disposal sites?

3. As the first-due Battalion Chief and the initial Incident Commander at DAL, can you describe how this type of information could support your decision-making regarding incident priorities and resource allocation?

Appendix J

From: bc07c Sent: Wed 2/26/2014 10:53 PM
To: Johnson, Lauren
Cc: bc07c; bc07a
Subject: RE: Chief Creager - Research Questions regarding DAL map

I would like to thank you for considering my input on your project. I have been a battalion chief over the area that answers alerts at Dallas Love Field for less than a year. I have looked at areas to improve my battalion, but neglected looking at ways to assist me when answering alerts at the airport. We currently do not carry any maps on the chief's car of the airport. The map you are constructing will be a valuable resource when answering runs. Asking me for my input has provided me an opportunity to look and evaluate what will help me in the future at Love Field.

1) As an Incident Commander, the type of information I would like to see on a map of Dallas Love Field Airport:

a. The most critical need at any fire is water. I would like to know the location of all the water hydrants on the field. This will allow me to determine the best way to establish a permanent water supply to the scene.

b. Any large incident is going to require a large number of off field resources, so I would like to know the location of all my access points, ie. gate locations.

c. Do to the large amount of fuel on airports I would like to know the location of all the fuel areas such as fuel farms, fbo's, and fueling stations.

d. Do to the possibility of an incident inside the airport terminal I would like to know the location and layout of the terminal.

e. Love Field has a Blast Area in case of a bomb on board an aircraft, I would like to know where is area is located on the map. This way I can determine the best location for my companies to standby.

f. Do to the possibility of large amounts of fuel on the ground during a crash, I would like to know the location of the airport storm drains.

g. Of course I would like the layout of the taxiways and runways.

h. All movement on the airport must go through the ATC so I would like the location of the ATC on the map.

i. The ARFF personnel use a grid system when answering alerts at the airport. I would like this grid system on the map.

j. There are paint booths used to paint airplanes. This area stores large amounts of flammable materials. I would like to know their locations on the map.

k. We have a small lake at the end of the airport. Knowing this could play a role in my incident makes it important piece on the map.

l. I would like to know the location of any structure that could be considered a "Target Hazard"

2) Currently, what DFR resources can you use to identify locations at DAL:

a. Currently the only DFR resource I have is my ARFF officers assigned at the airport. I have to rely solely on their KSA's of the airport. When an alert call comes in, I respond "blindly" to a location where a police officer is located to escort me. I then call the ARFF officer on the radio and ask them what they have.

3) As the first-due Battalion Chief and the initial IC at DAL, can you describe how this type of information could support your decision-making regarding incident priorities and resource allocation?

a. This information would GREATLY support my decision-making and help with resource allocation. In the fire service we all know the importance of size up, which starts as soon as the run comes in. Being able to study a map while enroute and forming that mental size up is vital. Gather information from a map while enroute and once on scene would assist me in every aspect of my job as the incident commander. From determining access points, staging locations, rehab locations, specific hazard locations, evacuation routes, exposure problems, water supply, apparatus placement, utilities cut offs, and street closures. There is really no area this map would not be useful. Not only would this map play a key role at any incident, but I would also use it in both pre-fire planning and training exercises. Using the map in this manner would help me uncover new areas to use it that I may not have thought of previous to a serious incident at DAL.

Appendix K

From: Johnson, Lauren Sent: Fri 2/21/2014 2:25 PM
To: Meador, Michael
Cc:
Subject: Research Questions regarding DAL map

Chief Meador,

Thank you so much for agreeing to answer a few questions regarding your response, as a DFR Incident Commander, to a large-scale emergency at Dallas Love Field Airport.

To follow up on our phone call, I'd like to provide you with some background information. I am developing a map that identifies critical infrastructure, resources, assets, and hazards and DAL. This map will be the final product of an applied research project that is required for the Executive Fire Officer Program. The goal of my project is to improve emergency preparedness in the city of Dallas. Please answer these questions in any matter that you would like. You can respond directly to this e-mail or call me if you prefer; in either case, your answers can be informal. A copy of this e-mail will be included in the appendix of my project, and so will a summary of your responses. However, your contact information will not be listed (your e-mail addresses will be redacted). Please contact me if you have any questions or concerns.

1. As an Incident Commander, what types of information would you like to see on a map of Dallas Love Field Airport?

2. Currently, what DFR resources can you use to identify locations at DAL that are:

a) fire department resources, like hydrants and access gates?

b) assets that can support emergency operations, like the Airport EOC, DPD offices, areas suitable for staging and triage?

c) critical infrastructure that is vital to airport operations and the well-being of the city, like gas and electric utilities, and the ATC control tower?

d) special hazards, like hazmat containers, maintenance hangars, fuel farms, biohazard disposal sites?

3. As the first-due Battalion Chief and the initial Incident Commander at DAL, can you describe how this type of information could support your decision-making regarding incident priorities and resource allocation?

Appendix L

From: Meador, Michael Sent: Tue 2/25/2014 9:45 AM
To: Johnson, Lauren
Cc: Meador, Michael
Subject: RE: Research Questions regarding DAL map

1. As an Incident Commander, what types of information would you like to see on a map of Dallas Love Field Airport?

As a incident commander I would like to see a map that provides a detailed perspective of the over all airport. A map should first and foremost provide a clear and easly understood routes to make access onto the airport property. As with many incidents controlling the flow of emergency apparatus along with having the most direct and safe route to the location will directly lead to the success of the incident. I also believe it is important to detail target hazards on the property including access routes that can be used in response to these areas. This would provide a two part benefit for incident commanders on airport incidents. 1. It would allow emergency operations personnel to visit the sites deemed "Hazards" prior to an incident in order to gather valuable information about the property. 2. Since the target hazard is noted on the map and a pre-incident survey has been done that information then could be placed on indexed information sheets that could be used at an incident.

I would also like to see key resources detailed on the map such as hydrants, FDC's, Staging areas, and preferred evacuation/ safe refuge areas on the airport. This would help to reduce any lag in decision making for a incident commander who was familiar with the map and it's uses.

2. Currently, what DFR resources can you use to identify locations at DAL that are:

a) fire department resources, like hydrants and access gates?

The department currently has three maps that can be used for incidents on or close to the airport. One map is used to identify hydrants on the airport in relation to the overall airport layout. Unless you are very familiar with the layout this map would provide very little assistance at an actual emergency.

A second map is used to detail location of access gates to the airport it also has an index of all usable gates on the back which provides a user-friendly resource.

The third map is vague diagram of the north end area of the airport where Bachman Lake is located which includes pole marker locations around the lake.

There are also procedures in place in our SOP's that give a general written guide of gate locations along with answering emergency incidents on the airport.

b) assets that can support emergency operations, like the Airport EOC, DPD offices, areas suitable for staging and triage?

I am not aware of any direct resources that detail locations of these type of support location. I would have to rely heavily on airport emergency operation personnel and police officers.

c) critical infrastructure that is vital to airport operations and the well-being of the city, like gas and electric utilities, and the ATC control tower?

Other than my own general knowledge of the airport layout there are no resources other than airport employees that details these infrastructures.

d) special hazards, like hazmat containers, maintenance hangars, fuel farms, biohazard disposal sites?

The department has been made aware of certain buildings that pose certain problems if involved in a emergency such as a fire but no in depth information is available. Once again if a significant emergency involving these areas where to happen we would have to rely heavily on personnel knowledge along with support from airport resources.

3. As the first-due Battalion Chief and the initial Incident Commander at DAL, can you describe how this type of information could support your decision-making regarding incident priorities and resource allocation?

I believe that a detailed map along with pertinent support information will provide a valuable tool for any Incident Commander. This type of information helps set the tone of the incident by providing detailed access that should be understood by all responding entities. I believe that when responding to an incident any information that is available helps the incident commander begin the thought process of resolving any possible issues that may exist when they arrive. If this tool where available to all responding companies it would definitely take the guess out of the location and general information about a particular hazard. It would also allow the incident commander to set priorities and develop objectives for the incident prior to arriving on the scene.